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EDITORIAL

THE FRUIT GROWING INDUSTRY

THE people of this country have, in the jargon of the day, become "fruit conscious." On the one hand the prolonged stagnation in the three major products has induced agriculturalists to turn more and more to fruit growing as an investment; on the other the "Eat more fruit" slogan, which is based on sound principles of dietary science, has stimulated the public demand for fruit. These conditions are very favourable to the creation of a prosperous industry, but neither the producer nor the consumer is satisfied. The former complains that he can find no market for the sale of his produce; the latter that it is difficult and sometimes impossible to obtain good locally grown fresh fruit.

There is good cause for both these complaints. Most fruits ripen within a very short season, and in May the market is glutted. Oranges sell now at one rupee per hundred, mangoes at less than a rupee per hundred, and pineapples at whatever the producer can get for them. A month hence the very rare specimen that ripens outside the season commands a scarcity price. Some producers try to defeat nature by marketing immature fruit in the early months of the year, but they only succeed in increasing the dissatisfaction of the consumer. The present efforts of the Department of Agriculture to increase the production of fruit in this country must fail unless provision is made for storage or successful experiments are carried out to discover cultural methods which will extend the ripening season over at least half the year.

We have heard of enthusiastic orchardists in the Northern Province who have succeeded in keeping a part of their orchards always in fruit by a course of differential and graduated irrigation. The systematic scientific investigation of these casual and fitful individual efforts, as well as the launching of co-ordinated experiments on a more extensive scale, awaits the expansion of the economic branch of the Agricultural Department by the appointment of a trained horticulturist as a full time officer.

In the article on the mangosteen reproduced in this number there is a paragraph dealing with experimental consignments of mangosteens under refrigeration from Burma to the United Kingdom. A large measure of success has been achieved, and it will not be long before a lucrative export trade in this fruit is established—in which trade, incidentally, Ceylon may be able to participate. There is no reason, however, why refrigeration methods should be applied only to the mangosteen or for the purposes of an export trade. The future of the fruit growing industry in this country seems to depend upon the general application of these methods of cold storage to fruit of all kinds intended for the local market. Before the State undertakes experiments for this purpose it is necessary that the public should appreciate the nature and scope of the commitment. The Burmese trials with the mangosteen prove that satisfactory refrigerator conditions are not obtained by merely placing fruit in a cold chamber. Prolonged experiments have to be carried out to find out the optimum maturity of the fruit for refrigeration, the best form of pre-treatment, the exact temperature at which the fruit should be stored and, perhaps, the air pressure which should be maintained in the chamber. After the expenditure of money over a long period on these and other details, the experiments might register a failure. Even if they achieve success, it will be sometime before the public can be induced to take up fruit growing under orchard conditions which is quite necessary to secure large quantities of fruit of uniform quality and maturity. The difficulties are many and the possibility of failure not negligible. The State must either face the risk of failure and find the necessary funds, or give up its attempts to encourage the cultivation of fruit. There is no other possible alternative.

SOME NOTES ON THE CITRUS INDUSTRY OF PALESTINE

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IN April-May 1935 I had the opportunity of visiting Palestine and during my month's stay in that country was enabled, through the kind services of the Imperial Chemical Industries (Levant Ltd.) and the Department of Agriculture, Palestine to obtain a first-hand acquaintance with the present position of its citrus industry, the main industry of the country. It was somewhat unfortunate that the visit coincided with the tail end of the citrus season, but that did not interfere to any extent with the main objective of the visit from the agricultural standpoint. In view of the increasing interest being taken in citrus cultivation in Ceylon, it was thought that some notes on the subject would not be without value to local citrus growers. The observations do not cover the whole field of citrus culture, but are mainly confined to the climatic. soil and general cultural aspects of the crop in Palestine. In the course of my stay I visited in connection with this study the Mikveh Israel Agricultural College, the Jewish Agency Experiment Station at Rehovoth, the Sieff Research Institute, the Department of Agriculture Horticultural Stations at Acre and Sarafand, the Kadoorie Agricultural School at Mount Tabor, the Hebrew University, the Government Chemical Laboratory, the Fruit Inspection Service at Jaffa, a number of private citrus groves, both Jewish and Arab, some of the new Jewish settlements, the Rehovoth Co-operative Growers' Factory and the Palestine " Frutarom " Ltd.

CITRUS AREAS AND TRADE

Citrus is cultivated in Palestine, mainly on the coastal plain, but the extension of the crop to the slopes and foothills is gradually taking place. Typical citrus country is level or gently rolling. The belt extends from Gaza in the south through Jaffa to Haifa in the north, a distance of about 105 miles, and has a maximum width of about 15 miles with an average of about 5. The acreage reported under the crop was in October 1932, 132,225 dunams or over 30,000 acres. Later

reports indicate that this area has been appreciably increased. The export of citrus fruit from Palestine in the 1934-1935 season was reported to amount to nearly 7½ million cases, and it is expected that in a few years this figure would be doubled, if not trebled. The export season for oranges is from November to April and for grapefruit from October to about March. The first date of export of citrus fruit from Palestine is governed by Regulations under the Fruit Export Ordinance of 1927.

CLIMATE

The climate of the citrus area of Palestine may be considered to be of the Mediterranean type—hot, dry summers and mild, rainy winters. The mean average temperature in the Jaffa district, a typical citrus area, is 19·4° C. or 66·9° F., the minimum being in January with an average of 12·1° C. or 53·8° F. and the maximum in August with 25·9° C. or 78·6° F. The average annual rainfall in the district is 554 mm. or approximately 22 inches, practically all of which falls from October to April. Areas further north have lower average temperatures and a somewhat higher rainfall. A rainfall of 30 inches is considered very good in Palestine. The relative humidity of the Jaffa area is 71 per cent. varying from 68 in September to 75 in December and January.

GEOLOGY AND SOILS

The geology of the citrus area is comparatively simple. With the exception of the sand dunes and a narrow alluvial belt, the entire area is underlain by marine and terrestrial flood deposits (diluvium). The former is considered to give rise to the characteristic red sandy soils of the coastal region and the latter to the dark brown to grey black marly loams (2). The red soils are generally deep extending to over 2 metres or 6 feet depth. They vary in texture from light sands containing 2 per cent. clay and silt and 98 per cent. sand, to fairly heavy loams containing 30 per cent. or more of clay and silt and 70 per cent. or less of sand. The lighter soils predominate in the coastal belt. The sub-soils are of slightly heavier texture. These soils drain well, sometimes excessively. Free calcium carbonate is normally absent, but small fragments of limestone do occur occasionally. The lighter red soils appear to be derived from calcareous sandstone (3) and the heavier types from other calcareous rocks. The soils are generally classed by Raczkowski (2) as Mediterranean red soils *terra rossa*, though this term appears more applicable to the red

loams. The value of the red sandy soils lies mainly in their beneficial physical properties. Citrus is a crop very susceptible to bad soil drainage, and heavy loams and clay soils, unless they contain a sufficiency of lime either free or available, are generally unsuitable, especially for oranges. Excessive amounts of free calcium carbonate in the soil are also harmful. Chemically, the red soils are generally poor in organic matter and nitrogen and also in potash and phosphoric acid when compared with the most local soils. The averages for nitrogen, phosphoric acid and potash are ·03–·09 per cent., 01 to ·03 per cent., and ·04 to ·14 per cent. respectively. These amounts are however considered adequate for normal grain production in the country. For citrus however, manuring is considered essential. The replaceable base contents of these soils are nevertheless much higher than those of local soils. On sandy soils they vary from 6 to 18 mgm. equivalents and on the heavier soils from 40 to 80 and more. Lime predominates. In reaction the soils are generally neutral to slightly alkaline. The more loamy types are similar to the Jaffna and other limestone —derived soils of Ceylon.

On the light red soils areas occur occasionally in which a clay hard pan with concretions of iron oxide and alumina, are found at varying depths. These soils, called the 'Nazaz' soils, are quite unsuited for citrus as the clay layer prevents root penetration and impedes drainage and soil aeration. In other areas shallow soils occur with calcareous sandstone so near the surface that root development is restricted and crop growth very poor. In others again a calcareous gravel known as "Kurkar," formed by the weathering of sandstone, is found. Both these types of soil are definitely unsuited to the crop (3).

The other classes of soils on which citrus is grown, though to a smaller extent, are the marly loams. The sub-soil is of heavier texture and reaches considerable depths. Calcium carbonate is usually found in fairly appreciable amounts. Drainage conditions are generally favourable and soil reaction is neutral or slightly alkaline. Analyses of these soils show that the clay content may be as much as 38 per cent., but their heavy texture is counteracted by the lime. For citrus cultivation a soil containing 15 to 25 per cent. clay and sufficient replaceable lime is ideal These soils are richer chemically than the red soils. Potash is high, 0 5 per cent., on the average; nitrogen, regarded as adequate, averages ·06 to ·09 per cent.; and phosphoric acid varies from ·01 to ·05 per

cent. Great care is required when irrigation is practised on these soils lest harmful alkali be formed.

The lighter soil types in Palestine are found more suitable for oranges and the heavier types for grapefruit. For either species of citrus, good soil drainage is essential.

VARIETIES AND CULTIVATION

Varieties.—The two most common local types of oranges in Palestine are the *Shamouti*, which only is legally entitled to the designation "Jaffa Orange" and the *Beledi*, the round and seedy type. The only other variety grown to any extent is the Valencia Late. Of grapefruit, Marsh's seedless is the chief variety cultivated.

Stocks.—The two main root stocks used for budding are the sour or bitter orange (*Citrus aurantium*) and the sweet lime or lemon (*Citrus aurantifolia*). The sour orange stock is used on heavier soils and the sweet lime on the light soils. The use of the latter stock is however gradually being given up owing to its susceptibility to gummosis to which the former is very resistant. Sour orange is found to be the best stock for grapefruit and Valencias. Trees on sweet lime stock are reported to fruit earlier than those on sour orange, but the latter bear better after a certain period. The effects of the stock on the vitality of the tree and its yield were very clearly demonstrated at Lord Melchett's Farm at Migdal on the Lake of Tiberias. The soil is a heavy loam, not quite suitable for oranges. Trees planted on sweet lime were carrying only fair crops and were showing "gummosis" and die back. Those on sour orange, though younger, were much bigger, bearing better, and free from disease.

Budding and Training.—The practice in the past in Palestine was to bud high—18 to 24 in. from the ground in order to avoid trouble from gummosis; but the normal budding height is now more generally from 8 to 10 in. Great care is devoted, when planting new groves, to training the young plants to give suitable shaped trees. High planting of budded plants is advocated owing to the danger from gummosis of low planting.

Planting Distances.—In the older groves the trees are very closely planted. In newly planted groves the planting distance for oranges varies from 4 × 4 metres (approx. 13 × 13 ft.) to 6 × 6 metres (20 × 20 ft.) and even 7 × 7 metres. For grapefruit the distances are somewhat greater, 5 × 5 metres or 16 × 16 ft. being common.

Cultivation.—In the older groves hand cultivation is still adopted owing to the closeness of planting. In modern groves mechanical cultivation is being employed with success. The importance of organic matter for citrus on these soils is well recognised and the planting of green manure crops in the winter to be ploughed in later, is frequently done. Lupines (*Lupinus* spp.) are often used for the purpose. Not much pruning is done, a good foliage on the tree being considered advantageous from the point of view of moisture conservation.

Irrigation.—Owing to the almost total lack of rain from May to September, irrigation is essential during this period. Irrigation water is obtained mainly from wells and from pipe lines with filters sunk to much greater depths than those of the water table, when the quantity of ground water is insufficient for intensive irrigation. It is distributed in some groves, through open concrete pipes or flumes. Water table depths vary from 10 to 40 metres (30 to 130 ft. approximately) in summer and pipe lengths from 14 to 60 metres (45 to 190 ft. approximately). Palestine well waters are generally rich in lime. Very occasionally river water is used for irrigation, if available.

The system of irrigation commonly practised especially in closely planted groves and on light soils is that known as 'basin irrigation,' the water being let into depressions around the trees. Irrigation is given once a fortnight or about 10 to 12 times a year on the heavier types of soils. On the lighter soils more frequent irrigation is done. These soils require much more irrigation water than the former. Experiments are in progress to determine the optimum duty of water for citrus cultivation, at some of the Stations of the Department of Agriculture. Great care has to be taken with this system of irrigation to prevent the development of gummosis. On some groves mounds of earth are made round each tree so that the water does not come into actual contact with the trunks of the trees while irrigating. In groves where the planting distance and soil conditions permit, furrow irrigation is adopted. The quality of the irrigation water is very important, for it has been found (4) that if its chlorine content is greater than 350 parts per million, indicating an excess of sodium chloride, the development of the tree is bad, yields are poor, the leaves become mottled or chlorotic and the tree itself may die, should the irrigation be continued over long periods. The texture of the heavier soils is also adversely affected thereby.

Manuring.—The manuring of groves in some form or other is general all over Palestine. Farmyard manure is applied to bearing trees just before or at the beginning of the rains, *i.e.*, in September-October, at the rate of about two baskets (30 kgm. or 66 lb.) per tree. The manure is ploughed between the rows of trees. Artificials are generally applied a month or so before blossoming, *i.e.*, about February or March.

Nitrogen has been found essential for good yields of citrus crops and about half of this constituent is applied in organic form, *i.e.*, as farmyard manure. The other half, if supplied in the form of sulphate of ammonia, as is often the case, is given at the rate of about 1 to 1½ kilos (2 to 3 lb.) per tree. Nitrochalk (containing 15·5 per cent. nitrogen) is being used in increasing quantities. Potash and phosphoric acid have been found at the Mikveh Israel Agricultural School to be indispensable for the first ten years after planting the crop. This is borne out by the comprehensive lysimeter trials there. At one private grove these constituents are applied in the following proportions: superphosphate 500 gm. (about 1 lb.), sulphate of potash 250 gm. (about ½ lb). They are applied with the cattle manure, at the same time as the nitrogenous fertiliser or even a little later. The method of application of fertilisers varies. Occasionally they are applied in the irrigation furrows, in some groves round the trees and in others between the rows.

Liming is generally done on the red sandy soils devoid of lime once every two or three years at the rate of 4 to 6 cwt. per acre. Ground limestone is recommended for light soils and slaked lime for heavy soils. Lime appears to be essential for proper citrus growth (5). A deficiency is occasionally indicated by a chlorosis, scorching or mottling of the leaves.

Yields.—With proper care and attention citrus plants begin to bear in four years. The average yield on well-cultivated, bearing groves is two boxes per tree. On some groves up to three boxes per tree are obtained. The variation in number of fruit per case ranges from 96 to 360 (average 144) with oranges and from 54 to 150 (average 80) with grapefruit.

Pests and Diseases.—The most serious pest in Palestine is Black Scale (*Chrysomphalus aonidum*) which is mainly confined to the north of the country. Government regulations prohibit the transport of fruit from north to south for this reason. Compulsory fumigation with hydrocyanic acid gas once or twice a year is now in force, the method of tent fumigation

being adopted. The fumigation is carried out by individual growers themselves or by the Government contractors (The Imperial Chemical Industries, Levant Ltd.) at a pre-arranged rate. This was approximately 4 piastres or 9d. per tree in 1935. The other pest which is causing anxiety is the Red Scale (*Chrysomphalus aurantii*). Fumigation has been found preferable to spraying as a control measure. The Mediterranean Fruit Fly (*Ceratitus capitata*) is only serious from March onwards.

The most serious diseases of citrus in Palestine are those comprised under the general term "gummosis". The use of sweet lime stock, improper irrigation, low planting and the accumulation of soil around the trunk are mainly responsible for the trouble. "Black rot" (*Diplodia natalensis*) is unusually severe in Palestine. "De-buttoning" of fruit and the pruning away of "die back" is advocated as control measures. A new disease of a rather serious nature called 'Xyloporosis' which appears to be caused by physiological factors, was discovered in 1930 (6). Neither canker (*Pseudomonas citri*) nor leaf miner (*Phyllocnistis citrella*) so prevalent on citrus in Ceylon occurs in Palestine. Lime washing of the trees every year with a mixture of lime and sulphate of copper is adopted by progressive growers.

Grading, Packing and Export.—Under the Regulations of the Fruit Export Ordinance 1927, registered exporters are permitted to export citrus fruit from Palestine only after they have satisfied the officers of the Fruit Inspection Service that the consignments are up to the standards prescribed. The sizes of boxes, grades of fruit, number of fruit to the box, labelling of fruit and boxes, etc., are regulated by law. The grades are as follows: Extra Large, Large and Ordinary. The American system of packing appears to be generally adopted. Grading has in the past been done largely by eye, but modern methods of grading and packing are being employed by progressive export agencies. Washing of the fruit is not done, neither is artificial colouring on any scale at present.

Citrus By-Products.—At the Rehovoth Co-operative Growers' Factory, the manufacture of orange oil, orange juice, pectin and other by-products of citrus is undertaken. The manufacture of fruit juices, marmalade, essences, etc., is also carried out in one or two private factories. The canning of oranges, etc., is not yet done on a commercial scale, though the question was investigated by an expert from England—Mr. F. Hirst, Director of the Campden Fruit Preservation Station.

Research.—Much valuable research work on citrus cultivation is being done at the Mikveh Israel Agricultural School, in particular on questions relating to vegetative propagation and the manuring of citrus soils ; at the Jewish Agency Research Experiment Station, Rehovoth, on all aspects of citrus cultivation and the utilisation of the by-products of citrus ; at various Horticultural Stations of the Department of Agriculture and elsewhere. The Government grants an annual subsidy to the Jewish Agency for citrus research at Rehovoth and close co-operation exists between this station and the Government citrus demonstration station at Sarafand. At the Sieff Research Institute work of a more fundamental and long-range nature is undertaken.

POINTS OF LOCAL INTEREST

Sufficient has been written to indicate the general lines of citrus cultivation in Palestine. It may perhaps be advantageous before concluding to draw the attention of local growers of the crop to certain points relating to citrus soils and manuring in particular, which may prove of some benefit to them.

These are as follows :

(1) Not all soils are suited for citrus cultivation. A soil of depth about 6 ft. is generally necessary for successful cultivation. It should neither be too sandy nor heavy, loamy sands and light to medium loams being best. Soils derived from limestone rocks whether sedimentary or crystalline are very suitable. Good drainage is essential, a clay or other hard pan within a 6 ft. depth, even on light soils, being harmful.

(2) Nor are all climates suited to the crop. The rainfall must not be too high nor continuous. A fairly long dry season would appear to be beneficial, especially for oranges. Irrigation during the period of drought may be found essential. The irrigation water must however be of good quality. Where irrigation is not possible, the conservation of soil moisture by mulching and other dry farming measures is most important.

(3) A stock suited to the nature of the crop grown and the climatic conditions of the district should be chosen.

(4) Manuring with organic manures and with artificials, especially the former, will be necessary if continued good crops are to be obtained. Nitrogen is an important plant food constituent of citrus. Potash and phosphoric acid will also be required, especially on the lighter soils. Periodical liming, especially of our acid soils, would be found essential. Ground

limestone is advised for the lighter soils and burnt lime for heavy soils. The growing and turning in of green manure crops should also prove advantageous on soils poor in organic matter.

(5) Tree sanitation, and treatment against pests and diseases are very important with citrus.

(6) Some of the areas in Ceylon which appear to satisfy, to some degree at any rate, the soil and rainfall (its incidence) conditions required for citrus cultivation, are : the Bandarawela, Welimada, Bibile, Medagama and other areas of the Uva Province, the Jaffna and Vavuniya districts, Nalanda and Dambulla districts, Embilipitiya and surrounding areas, certain areas in the Chilaw-Puttalam district, and certain inland parts of the Tangalle-Hambantota district. Grapefruit appears to be much less selective in its requirements in these respects than oranges. The latter would probably give better quality fruit in the cooler districts. Long-period trials alone would show whether other factors militate against the successful establishment of citrus in these and other areas.

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MOTTLE LEAF OF CITRUS: ITS INCIDENCE AND CONTROL

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MOTTLE leaf or foliocellosis is a serious physiological disorder of citrus trees in Ceylon. Mandarins are the most susceptible of the citrus varieties grown in this country. Severe mottling has also been observed in Mediterranean Sweet, St. Michael, Valencia Late and Jaffa oranges, Marsh's Seedless and Triumph grapefruits and West Indian Limes.

The disease occurs on a variety of soil types, including light, sandy soils and heavy loams. A record of the areas from which mottle leaf has been reported, together with a classification* of the soils, is given below :

	Soil Type
Anuradhapura	Heavy loam
Chilaw	Loamy soil
Galle	Lateritic soil
Hewaheta	Lateritic soil
Kahawatta	Lateritic soil
Kandy	Lateritic soil
Katugastota	Lateritic soil
Kumbalgamuwa	Lateritic soil
Lunugala	Lateritic soil
Maha Illuppalama	Alluvial loam
Nalanda	Terra rossa loam (Magnesian limestone)
Nugegoda	Laterite to Lateritic soil
Peradeniya	Sandy soil
Talangama	Lateritic soil
Wariyapola	Residual sand
Welimada	Laterite to Lateritic soil

The relation between soil type and the incidence of mottle leaf is evidently very complex.

SYMPTOMS

The most characteristic symptom is the appearance of irregular, yellow areas between the veins of the leaves. Each yellow area arises as a slightly chlorotic spot which widens and

*The writer is indebted to the Chemical Division for the classification of soil types

MOTTLE LEAF OF MANDARIN

turns a deeper yellow. The tissues over the midrib and larger veins retain their chlorophyll even in advanced stages of the disorder. This green tissue fades gradually into the yellow, intervenous patches.

In severe cases of mottling, leaves do not attain their full size and are very narrow, the trees are dwarfed and the quality of the fruit falls off.

The palisade cells of mottled leaves, unlike the tall cylindrical cells of normal leaves, are short and broad (1).

Mottled leaves contain a lower percentage of calcium and a higher percentage of phosphorus than normal leaves.

CAUSE OF THE DISORDER

The exact cause of mottle leaf is not known. It is not due to any parasitic organism. It is a functional disorder that can be corrected by the application of zinc sulphate; but it is probably not a simple zinc deficiency. Zinc, possibly through its effect on the oxidation reduction potential of the cell, seems to reduce the concentration of toxic nitrites in mottled leaves (2).

Soil factors influence the occurrence of mottle leaf. In some cases the disease has been controlled by the application of organic manures. The quantity of calcium seems to have a bearing on the incidence of mottle leaf, but the disease cannot be checked by administering calcium to the soil. Manuring with sodium nitrate can induce mottling in orange trees.

There appears to be a correlation between light intensity and the severity of mottling. Shaded leaves are less affected than leaves exposed to direct light.

CONTROL OF THE DISORDER

Mottle leaf may be controlled by the application of zinc sulphate to the soil at the rate of $\frac{1}{4}$ to 2 lb. per tree. Apart from the undesirability of the consequent accumulation of zinc sulphate in the soil, the recovery is a slow and uncertain process. Quicker results can be obtained by spraying the foliage with a mixture of zinc sulphate and hydrated lime, combined with a suitable spreader.

Mr. Lord, Officer-in-Charge, School Farm and Experiment Station, Peradeniya has found the following spray mixture effective :—

10 lb. zinc sulphate
5 lb. hydrated lime
$\frac{1}{2}$ lb. ' Solol '
100 gallons water

'Solol' is a proprietary, emulsified, petroleum oil, used as a spreader in this case.

The mycological division has also obtained satisfactory control with the following spray formula :—

10 lb. zinc sulphate
5 lb. hydrated lime
4 oz. 'Actin'
100 gallons water

'Actin' is a proprietary, neutral spreader.

The formulae are based on the recommendations of American workers (3, 4), who use zinc sulphate and hydrated lime with a blood albumen or calcium caseinate spreader.

There are different kinds of zinc sulphate containing varying amounts of water of crystallisation on the market. The kind to be used for the above formulae is one with the smallest proportion of water. This contains 89 per cent. water-free zinc sulphate.

Details of preparation of the spray mixture are as follows : The zinc sulphate is dissolved in a small quantity of water. Freshly burnt lime is hydrated and added to the main volume of water. The zinc sulphate solution is then poured into the lime suspension gradually, with continual stirring. The spreader is now stirred into the mixture. The spraying may be done with a knapsack sprayer provided with an agitator.

The exclusion of lime from the spray mixture results in serious spray injury by the zinc sulphate.

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PASTURE TRIALS AT PERADENIYA—II

RELATIVE PALATABILITY OF SOME PASTURE SPECIES

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INTRODUCTION

IN this Journal, Vol. LXXXII, No. 4, April, and No. 5, May, 1934 an account was given of the grasses under trial at Peradeniya. The present account treats of the continuance of this work and the results obtained on relative palatability of some of the grasses and leguminous plants from two grazing experiments.

OBJECTS OF INVESTIGATION

While it was known that all the species under trial were eaten by cattle, there were no definite indications so far concerning their relative palatability. Palatability is one of the chief factors which determine the value of a plant for pasture or fodder. The trials were carried out to determine the relative values of the species from the point of view of palatability. Incidentally, the relative periods of grazing during the different hours of the day from six a.m. to six p.m. were determined.

DESCRIPTION OF AREA AND ARRANGEMENT OF EXPERIMENT

The area consisted of thirty-five plots each one-tenth acre in extent and a strip of about half acre of *Paspalum dilatatum* Poir., that is, a total area of about four acres. This area was fenced all round. No separating barriers of any kind were allowed to exist between the plots or between the plots and the Paspalum strip. Thus any cattle introduced into the area could roam at will over the whole four-acre area. Each of thirty-one plots carried a grass species interplanted with *Desmodium triflorum* D.C., Hin-undupiyali (Sinh.). The remaining four plots were each a pure stand of one of the following leguminous species: *Alysicarpus vaginalis* D.C. (Asvenna, S.), *Desmodium heterophyllum* D.C. (Maha-

undupiyali, S.), *D. triflorum* D.C. (Hin-undupiyali, S.), and *Indigofera endecaphylla* Jacq.

The species were established from seed or rooted cuttings in June-July, 1933 and the pasture had been laid down some fifteen months before the commencement of the first palatability trial. The herbage on some of the plots had been cut back when it showed overgrowth and the whole area was kept free of coarse weeds. No manuring was done and no further attention was paid to the area in way of cultural treatment. At the commencement of the first trial the whole area was in more or less the same stage of overgrowth. The first trial lasted for 31 days from October 2 to November 2, 1934. During this period no other food was given to the cattle except for the last three days when a small amount of concentrates was given to all the animals. At the end of this period the pasturage was well grazed down and all the animals were in good condition. It was also seen that some of the species which used to be regarded as annuals lasted up to two years or more and were therefore biennials and short-lived perennials. This brings up another point concerning duration of plants of the wet tropics, that the same species may behave as annual, biennial, or short-lived perennial, depending on environmental conditions, particularly climate.

METHOD OF EXPERIMENT

FIRST PALATABILITY TRIAL

Into the fenced area of 4 acres, 15 head of indigenous black cattle were driven and the entrance closed. An observer was stationed at a point from which he could see the whole area. Using a watch he noted on a prepared "form" the time in minutes during which the cattle grazed on any particular plot. Two men were employed for this purpose, taking alternate four-hour periods in turn, from 6 a.m. to 6 p.m. each day for the 31 days of the trial. It may be pointed out that the success of this method depends mainly on how far cattle are gregarious in feeding and to some extent on the size of the plot. The cattle were gregarious and the plots were each one-tenth acre so that relative figures of fair accuracy were obtained.

SECOND PALATABILITY TRIAL

After the completion of the first trial the cattle were taken off from the area and the herbage was allowed to grow and seed undisturbed except for the removal of rank weeds

such as *Imperata cylindrica* Beauv., Lalang (E.), Illuk (S.), and *Rhynchelytrum roseum* Stapf et Hubb., Red-top grass (E.) During the earlier part of the South-West Monsoon rains, in June, 1935, the grasses were all cut back to about an inch from ground level and allowed to produce good grazing herbage. The block of 35 pasture plots was fenced in thus excluding the strip of *Paspalum dilatatum* included in the first trial. When the herbage had reached a suitable stage for grazing, in July, 1935, a second palatability trial was carried out on the same lines as the first. For the second trial eleven head of indigenous black cattle were used and grazing time recorded from 6 a.m. to 9 a.m., for the first seven days to obtain values for relative palatability.

RESULTS AND DISCUSSION OF RESULTS

(*a*) FIRST TRIAL

As the whole four-acre block was open, *i.e.*, without fences to separate one plot from another or from the Paspalum strip, the cattle were free to roam at will within the area, and as the four-acre block alone was able to supply sufficient grazing for the 15 head of cattle for 31 days, it can reasonably be assumed that during the first seven days of the trial the actual total of time spent in any plot affords a fairly accurate index of the relative palatability of the herbage of that particular plot. Thus the recorded time during which grazing was done on each plot during the first seven days was added and taken to indicate relative palatability. The plots arranged according to relative palatability thus obtained is shown in the table. In the case of the 31 plots in which a grass species was grown, the name of the grass is given to indicate the plot. For the other plots with pure leguminous species the specific name is given.

The period during which grazing was done during the different hours of the day from six a.m. to six p.m. during the trial was noted and is shown below :

6 a.m. to 7 a.m., 22 minutes.	12 p.m. to 1 p.m., 36 minutes.
7 a.m. to 8 a.m., 50 minutes.	1 p.m. to 2 p.m., 37 minutes.
8 a.m. to 9 a.m., 47 minutes.	2 p.m. to 3 p.m., 47 minutes.
9 a.m. to 10 a.m., 37 minutes.	3 p.m. to 4 p.m., 48 minutes.
10 a.m. to 11 a.m., 37 minutes.	4 p.m. to 5 p.m., 49 minutes.
11 a.m. to 12 noon, 39 minutes.	5 p.m. to 6 p.m., 47 minutes.

It is seen that cattle graze least during 6 a.m. to 7 a.m. and most from 7 a.m. to 9 a.m. and 2 p.m. to 6 p.m.

(*b*) SECOND TRIAL

The observations made during the first trial helped to modify the method of the second trial. Eleven head of indigenous black cattle were used. Relative palatability figures were recorded for only the first seven days, and the time of grazing during the three-hour period 6 a.m to 9 a.m. only, recorded. Relative palatability figures obtained from these records are given in the table side by side with the figures obtained from the first trial.

RELATIVE PALATABILITY OF PASTURE SPECIES

	1st Trial		*2nd Trial*	
1.	Axonopus compressus	15	Cenchrus ciliaris	21
2.	Brachiaria distachya	9	Stenotaphrum dimidiatum	7
3.	Alysicarpus vaginalis	6	Alysicarpus vaginalis	6
4.	Desmodium heterophyllum	4	Brachiaria distachya	6
5.	Setaria glauca	4	Paspalum dilatatum	5
6.	Indigofera endecaphylla	4	Amphilophis pertusa	5
7.	Apluda mutica	4	Cynodon plectostachyum	4
8.	Themeda tremula	3	Mixed grasses	4
9.	Paspalum conjugatum	2	Danthonia semiannularis	3
10.	Desmodium triflorum	2	Paspalum Metzii	3
11.	Stenotaphrum dimidiatum	2	Ischaemum imorense	3
12.	Digitaria marginata	2	Apluda mutica	2
13.	Amphilophis pertusa	2	Cynodon dactylon	2
14.	Panicum trypheron	2	Desmodium heterophyllum	2
15.	Dactyloctenium aegyptium	2	Hemigymnia javanica	1
16.	Paspalum dilatatum	2	Axonopus compressus	1
17.	Hemigymnia javanica	1	Sporobolus diander	1
18.	Mixed grasses	1	Eragrostis pilosa	1
19.	Alloteropsis cimicina	1	Desmodium triflorum	1
20.	Rhynchelytrum roseum	1	Setaria glauca	1
21.	Paspalidium flavidum	1	Digitaria marginata	1

	1st Trial		*2nd Trial*	
22.	Polytrias amaura	1	Alloteropsis cimicina	1
23.	Oplismenus compositus	1	Polytrias amaura	1
24.	Danthonia semiannularis	1	Themeda tremula	1
25.	Digitaria longiflora	1	Paspalum conjugatum	1
26.	Echinochloa colona	1	Panicum trypheron	0
27.	Cenchrus ciliaris	0	Paspalidium flavidum	0
28.	Eragrostis tenella	0	Eleusine indica	0
29.	Eleusine indica	0	Echinochloa colona	0
30.	Ischaemum timorense	0	Digitaria longiflora	0
31.	Paspalum Metzii	0	Oplismenus compositus	0
32.	Cynodon dactylon	0	Dactyloctenium aegyptium	0
33.	Ischaemum ciliare	0	Melinis minutiflora	0
34.	Sporobolus diander	0	Ischaemum ciliare	0
35.	Eragrostis pilosa	0		

(*c*) GENERAL

In the second trial the stage of maturity of the herbage was just right for grazing. These figures therefore give a truer indication of relative palatability under good pasture management whenever conditions are favourable, while the figures obtained in the first trial may be taken to represent relative palatability in times of drought as occur once or twice annually in many parts of Ceylon, when overgrown and dried up pasture plants are the only grazing available to stock. As stated earlier each grass species was grown with a leguminous plant which is of advantage not only in enhancing the value of the pasture but also in the development of the grass. Wherever the growth of the grass was thick the Desmodium was poor but under normal grazing conditions when the pasture is regularly grazed down from time to time the development of the leguminous plant can be expected to keep pace with that of the grass. It is necessary to comment on some of the individual plots. The *Digitaria pruriens* plot originally so planted was in a short time so much overrun with other grasses that it was allowed to exist as a plot of mixed herbage species, and the values obtained do not refer to the original species planted. In the first trial only about one-third of the Danthonia was well established, the rest having been planted a short time before the commencement of the first trial, so that the first trial figures for this

species are not accurate. The *Rhynchelytrum roseum* plot was discarded after the first trial as this became a bad weed in the other plots owing to its prolific seeding and the ease with which its light seed was dispersed by the wind. In its place *Pennisetum clandestinum* (Kikuyu grass) was planted but the latter was killed out by drought before it had any chance of establishing itself. *Indigofera endecaphylla* was ploughed up and the plot replanted with *Cynodon plectostachyum* after the first trial. The *Paspalidium flaridum* was attacked by a fungus, *Phyllachora graminis*, which practically killed it out before the commencement of the second trial. In the *Digitaria marginata* plot most of the parent clumps produced very much reduced "dwarf shoots". No fungus was found attacking the grass and this condition appeared to be due to some physiological cause. The *Echinochloa colona* showed very poor growth perhaps owing to the very low fertility of the soil, the pasture species in the trials having been established on poor soil without any application of manure. *Eragrostis tenella* was observed to be so poor during the first trial that it was discarded and the plot was replanted with *Melinis minutiflora*. This grass gives an offensive smell when crushed and the grass was not eaten at all by the cattle during the second trial. This grass being an exotic to which the cattle were not accustomed may prove to be a palatable grass or the cattle may be trained to like it in the future. It has a reputation of keeping off tick fever in some countries.

From these results it is seen that the leguminous plants have a high palatability. Of these *Alysicarpus vaginalis* was the best. Among the grasses some were very palatable while others had an extremely low value in this respect. From observations given above the following may be selected as having a higher palatability: *Cenchrus ciliaris* (African fox-tail grass), *Stenotaphrum dimidiatum*, *Brachiaria distachya*, *Paspalum dilatatum*, *Amphilophis pertusa*, *Axonopus compressus* (Carpet grass), *Cynodon plectostachyum* (African star grass), *Danthonia semiannularis* (Wallaby grass), *Apluda mutica* and *Digitaria marginata*. The last was not well represented for the second trial owing to the production of the "dwarf shoots" referred to above, in place of normal shoots.

It has been shown that the overgrown pasture of four acres supported 15 head of cattle for 31 days, that is, it had produced the equivalent of enough pasturage at this grazing to support one ox for 31×15 or 465 days.

The following are the rainfall figures during the period of the trials:—

	1933	1934	1935
January	12·92	8·47	2·47
February	3·68	3·67	4·47
March	6·33	9·22	7·07
April	6·36	9·49	2·84
May	30·50	6·26	1·81
June	9·09	8·32	6·38
July	10·49	3·70	3·99
August	9·17	1·19	6·55
September	8·79	0·69	—
October	12·58	11·16	—
November	12·26	6·71	—
December	2·12	4·43	—

The plots have already been described in the article referred to in the introduction. There were no replications. The land was flat in some plots while in others it was sloping. It is not possible to say how much this and similar differences could affect the figures obtained but it can reasonably be assumed that the large divergences shown in the figures of relative palatability enable the separation of more highly palatable species from the less palatable ones. Palatability represents only one important factor necessary to decide the value of plants for pasture or fodder. Other factors as digestibility, production per acre, resistance to adverse conditions such as drought and over-grazing, seasonal variations in feeding value have each a very important place in the choice of pasture species.

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NOTES ON ORCHIDS CULTIVATED IN CEYLON

EPIDENDRUM STAMFORDIANUM, BATEM

EDWARD PERERA,

CURATOR, HENERATGODA BOTANIC GARDENS, GAMPAHA

THIS is a handsome spotted-flowered species of very distinct character, being one of the few which produce a radical inflorescence. It has fusiform pseudobulbs a span long, tapering below into a slender scaly foot-stalk, and terminated by three or four oblong obtuse coriaceous leaves 6 or 7 inches long; the peduncle rises from the base and bears a large many-flowered panicle of fragrant blossoms which are 1½ inches across, of a bright yellow tinged with green, thickly decorated with blood-red spots, those of the petals being larger and fewer than those of the sepals, while the lip has the lateral lobes creamy-white and the front lobe yellow, the latter being sparingly spotted; the sepals and petals are lanceolate, the lip three-parted, flat, the lateral lobes large oblong, the middle one transversely oblong, emarginate and fimbriate; the type is described as having a vivid violet spot at the base of the lip, while in the variety *pictum* there is a crimson line down the centre of that organ. There are two varieties of this plant, one having much brighter coloured flowers than the other; the best form is characterised by having longer and thinner bulbs than the other. The flowers last for a considerable time in perfection.

Culture.—Pot culture is the best for these species, the drainage however must be perfect with about half the pots or pans filled with potshreds. They require the same treatment as the Cattleyas. A season of rest is very advantageous to the plants, causing them to flower more freely and to grow more vigorously afterwards. They are propagated by dividing the plants.

EPIDENDRUM STAMFORDIANUM, BATEM

DEPARTMENTAL NOTES

SUMMARY OF THE WORK OF THE ENTOMOLOGICAL DIVISION DURING 1935

THE following new insect pests were definitely recognised for the first time in Ceylon during the year.

Paddy stem-fly (*Atherigona* sp.) See Minor Investigations No. 4.

Coffee berry-borer (*Stephanoderes hampei*). See Major Investigations No 4.

The following new host plant records were made during the year :—

Host Plant	*Insect*	*Remarks*
Cacao (*Theobroma cacao*)	Cockchafer (*Rhinyptia* sp.)	Leaf-eating beetle
Mango (*Mangifera indica*)	Fruit-piercing moth (*Ophideres salaminia*)	Previously known to attack citrus fruit
Indigofera endecaphylla	Fluted scale (*Icerya purchasi*)	Formerly a declared pest of *Acacia*, etc., but legislation withdrawn some years ago
Gingelly (*Sesamum indicum*)	Green plant-bug (*Nezara viridula*)	Occurs on many leguminous plants
Guava (*Psidium Guajava*)	Leaf-rolling weevil (*Apoderus tranquebaricus*)	A minor pest of leaves of mango and avocado pear
Hydnocarpus sp.	*Cyclosia panthona*	Caterpillars usually attack leaves of *Baccaurea* spp.

MAJOR INVESTIGATIONS

1. *Lac cultivation.*—This has unfortunately received a serious set-back during the year. The prolonged drought has adversely affected the growth of inoculated kon trees and the insects have been unable to establish themselves on the dried up shoots. Parasites and predators have played their part in causing a reduction in the small number of insects which were

able to survive. The development of the lac insects has been irregular, with a shortening of the life-cycle and a decrease in the amount of brood-lac formed. Arrangements have been made to import further brood material from India early in 1936. Meanwhile suitable kon trees have been pruned in various districts and have put out a good supply of young wood which should be suitable for inoculation.

For the present it will be advisable to concentrate on two or three centres until a sufficient supply of local kon brood-lac is available for trial in other centres. Lac cultivated on masan (*Zizyphus jujuba*) has proved to be inferior to that on kon (*Schleichera trijuga*) and the cultivation of masan lac will not be continued.

2. The coconut caterpillar (*Nephantis serinopa*). The severe attacks of this pest in the Batticaloa district during 1934 continued during the first half of 1935 especially in Batticaloa South ; the attack in Batticaloa North was partially controlled by local fly parasites. Towards the end of the year the pest decreased rapidly after heavy rains and almost disappeared in many areas. Meanwhile, arrangements had been made earlier in the year to import from India some living material of *Trichospilus pupivora*, a pupal parasite of this pest, for breeding and distribution in the Batticaloa district. This parasite has been naturally established for many years in the Western and North-western parts of Ceylon, but was not available locally during the year.

This material arrived in November and the first generation was bred at Peradeniya. Meanwhile, an officer of the Entomological Division has been stationed at Batticaloa in charge of the breeding work which will be carried on in an insectary built for the purpose. Owing to the scarcity of *Nephantis* host material towards the end of the year it has been found necessary to breed the paddy swarming caterpillar (*Spodoptera mauritia*) in large numbers at Peradeniya and at Batticaloa as an alternate host for *Trichospilus*. A reserve breeding station will be maintained at Peradeniya.

Since hot dry weather is known to be favourable to the pest and definitely unfavourable to the natural increase of this parasite, the success of the undertaking remains to be seen. An attempt will be made, however, to breed *Trichospilus pupivora* in large numbers throughout 1936 for liberation in areas where the coconut caterpillar happens to appear, in the

hope that some degree of control may be established in the future.

3. *Termites.* (*a*) *Bionomics.*—The breeding of termites was continued during the year and winged adults of *Neotermes militaris*, the common up-country tea-termite, was produced towards the end of the year from a colony founded $8\frac{1}{2}$ years ago by a winged pair.

In the case of two colonies of *Planocryptotermes primus*, a dry-wood termite, winged adults appeared during the year from eggs laid by neoteinic (wingless) adults 6 years ago.

(*b*) *Tests of building materials.* These tests with materials reputed to possess termite repellent properties have been continued. A patent insulating wall-board fabric, although highly resistant to the attack of subterranean termites is not entirely immune. It appears to repel the attacks of dry-wood termites and is fatal to them when provided as food. A sample of timber, impregnated with a proprietary preparation claimed to possess termite-repellent properties and which has been under test for 18 months, has been extensively attacked by subterranean termites. Samples of timber treated with certain paints have so far proved resistant to attack after 14 months, while the untreated controls have suffered severe injury. A sample of timber treated with a rubber distillate solution has resisted attack during the $2\frac{1}{2}$ years of the test.

(*c*) *Control.*—The control of *Neotermes militaris* and *Glyptotermes dilatatus* in tea bushes by the injection of Paris Green powder into their active workings has been continued with success on many estates.

4. The coffee berry-borer (*Stephanoderes hampei*). A disturbing occurrence during the year was the discovery of this notorious pest in the Balangoda district. This small shot-hole borer is a serious menace to coffee cultivation in certain African and Eastern countries, but it was not previously known to occur in Ceylon. Towards the close of the year this insect was declared a pest under the Plant Protection Ordinance No. 10 of 1924. A systematic campaign was undertaken in the Balangoda district and the pest was found to be widely distributed within the district. Over 1,500 gardens were visited and over 30,000 coffee plants have been pruned and their berries destroyed. The assistance rendered to the Department by the Chief Headman of Balangoda and his officers in the performance of this work is much appreciated. A note on the bionomics of this pest will appear in a subsequent number.

MINOR INVESTIGATIONS

1. The lawn cricket (*Gymnogryllus humeralis*). The study of the life-cycle of this serious pest of grass lawns has been continued during the year. Adults were obtained from nymphs which appeared in May last, the cycle having occupied 5½ months from the time the eggs hatched

2. *Book poison tests.*—Tests of dummy volumes, treated with various insect-repelling mixtures, against cockroach and other insect injury have been continued on behalf of the Crown Agents for the Colonies during the year. The first series of volumes was returned to London after one year's exposure and, as a result of the experience gained, further volumes, treated with different mixtures, were received for similar exposure tests in June last. The treatments applied to these volumes appears to be far superior to those given to volumes of the earlier series, the new series having resisted insect damage during the six months of test.

3. Paddy swarming caterpillar (*Spodoptera mauritia*). A serious outbreak of this pest occurred over about 15 acres in the centre of a 70-acre block of paddy near Katugastota during October. The following control measures, promptly applied by an officer of this Division resulted in the destruction of the caterpillars and the saving of the block. The fields concerned were first flooded to as great a depth as the bunds would permit causing the caterpillars to ascend to the tops of the plants and preventing them from spreading to the surrounding unattacked area. The next step was to spray a solution of kerosene and crude oil, in equal parts, on to the surface of the water, care being taken to avoid the solution coming in contact with the foliage of the plants. A continuous film of oil was thus rapidly formed on the surface of the water. Men then entered the fields and lightly brushed the plants with bundles of twigs tied together to form brooms and the insects were thus swept from the plants to the films of oil below. On the following day the caterpillars which had been dislodged were found to be dead and those which had been missed in the first sweeping were brushed off. The water in the field was then completely drained off carrying the oil with it. In cases where attacked fields lend themselves to flooding to a suitable depth this method of control can be applied with success.

4. The paddy stem-fly (*Athcrigona* sp.). Towards the end of January reports were received from parts of the Central and Uva Provinces that extensive areas of seedling paddy were being

partially destroyed and, in some cases, entirely ruined, by an insect pest which proved to be a small anthomyid fly. Seedlings were attacked within a week after germination and in areas where there was a shortage of water the attacked plants were unable to tiller vigorously in many areas at least 50 per cent. o the seedlings were killed.

The maggots apparently cause primary damage by cutting through the young central shoot feeding inside the decaying portion and pupating inside the stem, usually near the base of the plant. The life-cycle occupies about two weeks, and the flies, in areas where paddy is sown at intervals of a few days are able to attack successive areas of young seedlings soon after germination. The pest was most destructive in areas where sowing had been delayed owing to the failure of the rains. Later, when more water became available, the attacked plants started to tiller vigorously and were able to throw off the attack. Reports on the presence, or otherwise, of the pest in the various districts indicated that it had been observed in the North-central and Eastern Provinces in addition to those mentioned above.

EXAMINATION OF IMPORTED AND OF EXPORTED PLANTS

(1) *Colombo.*—The number of imported packages received for inspection during the year was 14,633. Of this number 4,058 were fumigated prior to release. Citrus fruits represented 93 per cent. of the importations, the remainder consisting of cuttings, roots, bulbs, seeds and miscellaneous plants. Packages examined prior to export numbered 23,102.

(2) *Peradeniya.*—During the year, 379 packages were inspected, 197 of which were fumigated prior to export. The necessary certificates were issued, in duplicate, to cover these consignments.

FURTHER NOTE ON THE COCONUT CATERPILLAR PARASITE (*Trichospilus pupivora*).

As indicated in the above summary, the breeding of this parasite was started at Peradeniya and at Batticaloa towards the end of 1935. This work has been carried on successfully at both places and the following results have been obtained up to the end of April, 1936.

Peradeniya.—Out of about 48,000 parasites obtained so far, about 40,000 have been sent to Batticaloa for distribution in *Nephantis* areas and about 5,000 have been despatched to two

estates in the North-western Province where small outbreaks of the pest were reported. The remainder amounting to about 3,000 have been retained, a few hundred at each generation, for breeding purposes.

Batticaloa.—A total of about 124,000 parasites have been obtained to end of April, in addition to those received from Peradeniya. Of these, about 120,000 have been liberated mainly on various estates in the Batticaloa district. The remainder, approximately 4,000, have been retained at intervals for carrying on the breeding. Including the consignments received from Peradeniya it is estimated that at least 150,000 *Trichospilus* have been liberated in the Batticaloa district; some of the remainder being sent to the North-western Province, while some have died in the insectary during the recent hot weather.

The great majority of these parasites has been bred in the pupae of the paddy swarming caterpillar (*Spodoptera mauritia*) which breeds readily under favourable conditions and has proved to be a valuable alternate host. Another useful host is the pupa of the cotton leaf-folding caterpillar (*Sylepta derogata*) which has been available in fair numbers during the cotton season.

EXTRACTS FROM THE REPORT OF THE MYCOLOGIST FOR 1935

The following is a list of the diseases of plants recorded in Ceylon for the first time during 1935 :—

Aleurites montana (*tung-oil*)	Brown root disease	*Fomes noxius*
Artocarpus integra (jak)	Ripe rot	*Diplodia* sp.
Arctotis sp.	Wilt	Bacteria
Citrus aurantium (orange)	Collar rot	*Sclerotium Rolfsii*
Dolichos lab-lab	Leaf disease	*Cercospora cruenta*
Gossypium sp. (cotton)	Leaf disease	*Cercospora gossypina* and *Macrosporium* sp.
Hibiscus rosa-sinensis	(Shoe-flower) root disease	*Sphaerostilbe repens*
Laurus nobilis (bay tree)	Pink disease	*Corticium salmonicolor*
Passiflora quadrangularis (granadilla)	Leaf spot	*Macrosporium* sp.
Poinsettia sp.	Root disease	*Sphaerostilbe repens*
Pueraria javanica	Stem and leaf disease	*Rhizoctonia* (*Corticium*) *solani*
Spondias mangifera	Brown root disease	*Fomes noxius*
Swietenia mahogani (mahogany)	Collar disease (of young plants)	*Sclerotium Rolfsii*
Trichosanthes anguina (snake gourd)	Downy mildew of leaves	*Pseudoperonospora cubensis.*

TEA

An interesting case of leaf disease of tea caused by *Rhizoctonia* (*Corticium*) *solani* occurred on an estate in the Galle district of the Southern Province. Four or five bushes in a patch of tea four or five years of age were reported to be attacked. When the parcel containing the diseased specimens was opened the leaves were found firmly attached to each other by wefts of mycelium. The stems bearing the leaves were apparently healthy and loose *Rhizoctonia* mycelium was found on the surface. The fungus probably developed in the soil. ascended the stems and attacked the leaves.

CITRUS

An interesting case of collar rot of young imported grafted orange plants caused by *Sclerotium Rolfsii* was recorded. This is the first occurrence of this disease on citrus in Ceylon. In this instance, it is suspected that the fungus spread to the orange plants from decaying vegetable matter used in the holes or as a mulch. One affected graft appeared to be a vigorous plant and was just over two centimetres in diameter at the collar. The bark along one side of the stock and at the collar had decayed and there was an abundance of white strands of mycelium about the decayed portions. The mycelial strands had grown down the greater part of the tap root and of some of the lateral roots. Typical brown shiny sclerotia were produced on the masses of the mycelium at the collar and on the roots.

Curling and puckering of leaves of grapefruit was observed on the new flush that burst during the rains on trees which were subjected to a long spell of dry weather. This condition of the leaves was probably brought about by a sudden over-supply of soil moisture.

A disease of grapefruit trees affecting the bark of the trunk and larger branches sometimes accompanied by exudation of gum to the surface was of frequent occurrence during the long spell of dry weather. The first indication is a thin, longitudinal crack in the bark which gradually opens to expose the wood. The open wound heals over in time. In some cases *Diplodia* sp. accompanies the crack and the mycelium of the fungus enters the wood giving it a greyish tint and kills back the branch. It is thought that defoliation as a result of drought conditions leads to exposure and subsequent scorching of the branches by the sun which causes these wounds. Improving the protection of the plants from sun and wind and mulching them well throughout the dry season will do much to remedy any deficiencies in this respect. Shaving back the affected tissues to sound wood, painting over the wood with a disinfectant as a 20 per cent. solution of Brunolinum or Carbolineum and then tarring the wound has been found effective against this type of canker.

GREEN MUSCARDINE FUNGUS

During the latter part of last year larvae of the coconut beetle (*Oryctes rhinoceros*) were found naturally infected and killed by the green muscardine fungus (*Metarrhizium aniso-*

pliae) in Kochchikadde at an elevation a little above sea level. As larvae living under natural conditions were readily infected by artificial inoculations at an elevation of about 1,500 feet experiments were made to ascertain whether the fungus could be made to infect larvae at lower elevations.

Traps consisting of small pits filled with coconut debris mixed with fresh cattle dung were prepared on a coconut estate in the Kurunegala district (elevation about 500 feet) with a view to attracting the coconut beetle to lay its eggs in such traps. The traps proved attractive and larvae of the coconut beetle were found in them after about three months ; they were then inoculated by mixing the fungus grown on boiled rice with the surface soil. When the traps were examined after four weeks, the fungus was found to have attacked and killed all the larvae. The larvae in the control traps were free from infection during this period. An experiment was also made by inoculating a trap by introducing soil into it taken from a trap which had been previously inoculated seven weeks earlier. The larvae in this trap also were attacked and killed.

Results have indicated that it was necessary to keep the inoculated traps fairly moist ; that if the traps became too dry or saturated with too much moisture less deaths occur among the larvae ; and that the fungus can be introduced into traps at an elevation of 500 feet to cause successful infection.

COW-PEA

An experiment was made to ascertain the effect of colloidal sulphur against mildew (*Oidium* sp.) attacking cow-pea vines (*Me-karal*). Cow-pea seeds were sown in beds previously sterilized by watering the soil with a solution of Jeyes' fluid (1 oz. to one gallon of water). Nine weeks after sowing when the vines were attacked by *Oidium* sp. they were sprayed with colloidal sulphur in the proportion of 1 oz. colloidal sulphur to one gallon of water. The spraying was repeated after six days. The spray fluid completely controlled the fungus. The vines in an adjoining bed which were kept as a control were heavily infected and a large number of affected leaves dropped off the vines.

USTULINA

Inoculations made on tea roots with pure cultures of *Ustulina zonata* obtained from beech and lime (*Tilia*) in England and from tea and rubber in Ceylon gave results similar to those

recorded last year which were carried out on stems. The inoculations were examined after about 11 months when it was found that the extent of infection varied considerably with the different strains. The strain obtained from tea caused the most extensive infection involving the roots, the collar and stem up to a height of about nine inches. The strain from rubber had infected the tissues for a distance of only 7 10th of an inch, while the strain from lime and beech had caused practically no infection. As tea was not equally attacked by the different strains, it would appear that in the single species of *Ustulina zonata* there are present several specialized races or strains.

JAK

A new disease of Jak was reported from Jaffna. Small, soft, purplish-brown patches were found on the surface of the ripening fruit. Cultures made from diseased tissue developed *Diplodia* sp. When inoculations were made with this fungus on fully grown Jak fruits after wounding infection became visible after three days and on the following day the discoloured areas had extended further showing soft purplish-brown patches as on the specimen originally sent in. Inoculations were also made with spores of the fungus on Jak in nature on fully grown fruits. Ten days after inoculation the fruits had taken infection but the fungus had not penetrated into the pulp. When a ripening fruit was inoculated with the fungus in culture and the fruit covered with a bell glass the fungus overran the surface of the fruit and advanced into the pulp showing that warmth and humidity are favourable for the development of the fungus. The tendency for the fungus was to cause a premature ripening and the apparently ripe portions remain hard instead of becoming soft.

CHEMICAL NOTES (13)

CINCHONA BARK ANALYSES

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SIX samples of stem bark of *Cinchona Ledgeriana* were analysed for percentages of total alkaloids, quinine and cinchonidine. These were from Abergele estate, Boragas. They consisted of quilled pieces between five and six inches in length and two to three millimetres in thickness. The outer surface was wrinkled, rough, greyish in colour, possessed numerous transverse fissures of varying size and distinctness and was partly covered with lichens. This surface also showed longitudinal furrowing. The inner surface was yellowish brown in colour, coarsely striated and finely fibrous internally. The samples were bitter and astringent to the taste and had only a slight odour.

The percentage of total alkaloids was determined by the British Pharmacopoeia method of 1932. The quinine was estimated as quinine sulphate following the method in Vol. II of Thorpe's Dictionary of applied Chemistry. As the quinine is not completely precipitated under these conditions the residual quinine and cinchonidine were completely precipitated as tartrates.

The results are shown in the table.

ANALYSES OF CINCHONA BARK (*Cinchona Ledgeriana*) CALCULATED ON AIR-DRIED BARK

Series	% Total Alkaloids	% Quinine Sulphate	% Quinine	% Residual Quinine & Cinchonidine as Tartrate	% Residual Quinine & Cinchonidine	% Quinine & Cinchonidine
1	6·16	3·23	2·80	1·35	1·07	3·87
2	6·82	3·29	2·86	2·03	1·61	4·47
3	6·59	3·09	2·68	1·15	·91	3·59
4	6·99	3·23	2·80	1·74	1·39	4·19
5	7·70	3·57	3·10	1·69	1·35	4·45
6	6·58	3·23	2·80	1·79	1·42	4·22
Average	6·81	3·27	2·84	1·62	1·29	4·13

It is apparent that there is but little variation in both the percentages of total alkaloids and of quinine-cinchonidine in these specimens except for Nos. 1 and 3 which have slightly lower contents. Quinine-cinchonidine constitutes nearly two-thirds of the percentage of total alkaloids in nearly all cases. It should however be mentioned that cinchonidine is known to be present in only traces in this species of cinchona so that the figures obtained for total quinine and cinchonidine give a more correct estimate of the actual percentages of quinine in the samples. Moreover these two alkaloids are invariably estimated together.

These Ledgeriana barks cannot be considered as being of good quality as none of them contain even five per cent. of quinine. However, by the cultivation of the richer barks to the exclusion of the lower alkaloid producing varieties, it should be possible to obtain a Ledgeriana bark yielding over eight per cent. of quinine which alone may constitute about eighty-five per cent. of the total alkaloids present. Ledgeriana trees in Java are known to give quinine contents as high as 13·25 per cent.

THE PURIFICATION OF SEED LAC FOR POLISH MANUFACTURE

As polishes made with seed lac produced locally by furniture manufacturers did not prove satisfactory—tackiness being observed on articles polished with such preparations—investigations were carried out to ascertain the cause of the trouble and if possible to remedy it. It was considered that this was primarily due to the presence in the lac of substances that were soluble both in methylated spirits and water. It was therefore decided to free the seed lac of such impurities by thorough washing. This process, which involves the dissolution of a large amount of colouring matter, known as lac dye, is tedious. If the seed lac is washed instead with a four per cent. aqueous solution of sodium carbonate (washing soda), the lac dye together with other soluble constituents is easily removed. The material thereafter need only be washed a few times with water until the washings become practically free of colour. The loss in weight due to this treatment amounts to about twenty-five per cent., but the process is inexpensive.

One pound of washing soda in two and a half gallons of water is sufficient for purifying nearly twenty-five pounds of seed lac so that the cost of such treatment is less than half a cent per pound.

As the lac still contains a small quantity of foreign matter it may be advisable to use about twenty per cent. more seed lac than the requisite quantity used in similar shellac preparations.

Ordinary methylated spirits and spirits purified by treatment with burnt lime—half an ounce of lime was used for each bottle of spirits—were used in the preparation of French polish and trials made with a view to ascertaining whether the quality of the spirits also affected that of the polish. These trials revealed that whereas the purification of the seed lac in the manner described was necessary, the use of purified methylated spirits though desirable, is not essential.

Samples of French polish prepared from purified lac were favourably reported upon by a well-known firm of furniture dealers.

THE MANGOSTEEN

[Adapted from the Department of Agriculture, Burma—Agricultural Survey No. 23 of 1935 by W. Gregson, I.A.S., Deputy Director of Agriculture, Tenasserim Circle]

DESCRIPTION OF THE PLANT

THE Mangosteen plant is an evergreen lactiferous, slow growing tree ; black of bark with a pyramidal crown, growing to an average height of 30 feet. Individual trees cultivated under exceptionally favourable circumstances may reach a height of 35 to 45 feet, but such instances are rare.

The average tree may be expected to come into bearing at the ninth or tenth year, have a yielding period of 40 to 50 years and give the maximum yield between the fifteenth and thirtieth year of its life. At the commencing-to-bear stage it will yield 200 to 300 fruits, gradually working up to a maximum of 1,200 to 1,500. These figures must not be taken as indicating a consistent annual yield, for instance, a tree yielding 1,500 fruits one year will in all probability drop to 800 to 900 fruits in the following year. It is a recognised fact among the gardeners that one out of three is a bad yielding year. It should be understood, however, that trees vary in this respect according to situation, soil conditions and the amount of cultural attention they receive.

The tree is a slow grower ; but the slowest period of growth is during the first to fifth year, thereafter growth is approximately at double the rate.

The tree is generally accepted to be a lover of shade. While not denying that shade is perhaps essential in the young state, and probably beneficial at all stages of the tree's growth, the writer does not consider it to be absolutely essential, and knows of several orchards where shade is completely absent, yet the growth of the trees and yield of fruit is fully equal to that of trees growing under shade conditions.

The flowering date varies slightly according to locality, soil conditions and, if the situation demands it, whether irrigation is given during the dry season. However, as a rule, trees commence to flower in the middle of November and continue to do so until the end of January or early February. Fruits are obtainable from the middle of April and continue to be available until towards the end of July. The main fruiting season is May and June.

The vitality of the seed once it is removed from the fruit is soon destroyed, and quick planting is essential. If, however, the fruit is undamaged, carries no disease and is not too ripe when gathered, seeds removed from the fruit within a period about five weeks can be expected to give reasonable germination.

CLIMATIC AND SOIL CONDITIONS

The mangosteen is essentially a tropical plant and has so far only been successfully cultivated in a hot moist climate. In Ceylon the low-country

portion of the area which receives the heavy south-west monsoon rains has been found to be the most suitable for the cultivation of this fruit.

Deep, rich loams containing a fairly high percentage of organic matter with good natural drainage, yet capable of retaining a fair amount of moisture and situated near streams, springs or wells, are considered to be best suited.

A sheltered locality is to be preferred. The tree does not thrive, takes considerably longer to come into bearing and gives poor yields if planted in exposed positions. It is also much more difficult to establish, as once a plant becomes sickly there is no hope of its recovery.

METHODS OF CULTIVATION

Cultivation at the present time is mainly confined to mixed orchard-garden forms, and it is rarely that the mangosteen is cultivated as a pure crop. The tree is found growing mixed with Durian, Arecanut, Jak, Mango, Coconut and Marian. Betel vine is always grown, as are other ground crops, *i.e.*, Pine-apple, Arrowroot, Ginger, etc., if the shade is not too dense. Even in the few instances where the tree is grown as a pure crop, Betel vine is usually grown. Other varieties of ground crops such as are mentioned above may or may not be grown.

Although the growers distinguish good from bad yielding trees, no form of seed selection is practised. Seed is chosen haphazard and generally sown in bamboo pots which have been filled with surface and burnt soil in the proportion of 5 parts of the former to 3 parts of the latter. The young plants remain in the pots until they are ready for planting out, usually at the age of 2 to 3 years. Shade is provided during the hot season, also protection from heavy rains during the monsoon.

Nurseries are seldom employed, but if they are, the seed is planted approximately $1\frac{1}{2} \times 1\frac{1}{2}$ feet in raised beds composed of surface soil, burnt soil and possibly well rotted farmyard manure in the proportion of: surface soil 5 parts, burnt soil 3 parts, and, if farmyard manure is used, farmyard manure 1 part. Burnt soil is added to the beds as is thought necessary, and protection from sun and rain is provided.

The plants remain in the nursery beds until ready for planting out at the age of 2 to 3 years. Watering is done by hand during the dry weather and the beds are kept more or less free from weeds with an occasional stirring of the soil.

No special preparation of the site on which the young trees are to be finally planted is ever given, beyond that which is customary in orchard-garden cultivation. Pits are dug without any regard to spacing or proximity to neighbouring trees in the case of mixed orchard-garden cultivation, while if the intention is to cultivate as a pure crop, a careless spacing of approximately 20×20 feet is employed. The pits are approximately 2 feet in diameter and from 2 to $2\frac{1}{2}$ feet deep, and are dug and filled immediately before the rains. The material used as filling may be surface soil alone; or surface soil mixed with burnt soil in the proportion of 2 parts of the former to 1 part of the latter, or, surface soil and well rotted farmyard manure in the proportion of

4 parts of the former to 1 part of the latter. Occasionally rotted sessamum cake may take the place of farmyard manure.

If bamboo pots have been employed in raising the seedlings and they are not sufficiently rotten to allow for the whole object, pot and contents, to be dealt with as a whole, the pot is split in two and the two halves removed before planting. In all cases, however, great care is exercised to keep as much soil adhering, and to do as little damage as possible to the root system of the young plant.

No form of cultivation or manuring is practised, and it is for this reason that trees situated in the miscellaneous gardens are more healthy and yield a heavier crop of fruit than those trees in a garden devoted solely to the crop. This is due to the fact that apart from any direct cultivation that may be given, the trees in the mixed gardens receive benefit from manurial agents and cultivation given to other crops, *i.e.*, ground crops.

The method of harvesting consists, in the majority of cases, of cutting the fruit stalk by means of a knife attached to the end of a long bamboo and allowing the fruit to fall either on to the ground or into a cloth held underneath for the purpose.

It is worthy of note that no pruning of any kind is ever practised; neither is attention ever given to diseases and pests. The latter are not serious and do little if any damage, but the former cause considerable rotting of mature, and shedding of immature, fruits.

Owing to the long period which elapses before the tree arrives at the bearing stage, and the consequent delay before the growers receive a cash return, cultivation is not extending; rather is it tending to decrease. It is seldom that newly-planted trees are to be found.

SCOPE FOR IMPROVEMENT IN METHOD OF CULTIVATION

It is considered that one of the first lines of approach towards improvement of the crop by the growers can be by methods of seed selection. Seed should be obtained from consistently high-yielding trees and the fruit therefrom should be chosen for its size, shape and large proportion of flesh to seed. This is possible of accomplishment because the owners of long-established gardens can point to such trees almost with certainty.

The seed should be planted in raised nursery beds of convenient size, the soil of which is best if composed of surface soil (loam not too heavy) and leaf mould or well-rotted farmyard manure mixed together in the approximate proportion of 5 parts of the former to 1 part of the latter. A suitable planting distance being rows 2 feet apart and seed in the rows $1\frac{1}{2}$ feet apart. Deep planting is not advisable. The seed should be covered with just sufficient soil to prevent exposure on the beds being watered.

If not too large a number of seed are to be dealt with they can be planted direct into bamboo pots which have been previously filled, and the soil allowed to settle. Care must be taken if this method is followed that the level of the soil after settlement is level with the top of the pot, otherwise on germination the young plant does not receive the necessary amount of light and air, and in consequence becomes sickly, a condition which is generally fatal.

A good plan if bamboos are easily available and not too costly is to allow 1½ internodes for a pot. If this is done it is seldom necessary to repot before final planting out in the orchard.

The vigour of young plants both in the nursery beds and in pots, especially in the latter, can be considerably increased by the judicious and occasional use of a dilute solution of liquid fertilizer, *i.e.*, cow dung mixed with water in the proportion of 1 part of the former to 4 parts of the latter by bulk.

Both nursery beds and pots must be kept free from weeds at all stages of the plant's growth. The soil should also be given an occasional stirring to a depth of 1 to 2 inches, care being taken not to injure the young roots.

When the time arrives for the plants to be lifted from the nursery beds preparatory to their being planted out in the orchard, care must be taken to see that as little damage as possible is done to the lateral roots. The tap root if necessary may be cut back, but every endeavour should be made to avoid this if possible as it causes a serious halt in the young tree's growth.

Plants in bamboo pots can be treated as previously described. It is considered that whenever possible the bamboo pot method of raising plants should be employed as there is no check to the young plants when they are being planted out. It is also easier to give the necessary attention as regards shade and protection from heavy rains. The only drawback to the method being that it is sometimes difficult to obtain the required number of pots, or, even if available, too costly.

More careful attention than is now the case must be given to clearing the orchard site, lay out, spacing of the trees, cultivation and sanitation. Also every effort must be made to encourage prospective gardeners to grow the mangosteen as a pure crop, or at the most, only, mixed with a suitable shade fruit tree, *i.e.* Durian.

The site for the orchard must be cleared of all vegetation ; that is, jungle growth should be felled and burnt, as dead and decaying vegetation is always a possible source of disease. It is also advisable to work the land as soon as possible after burning operations have been completed.

A minimum spacing of 25 feet must be allowed between the trees ; 30 feet is to be preferred. If shade trees are planted, then no mangosteen should be nearer to the shade trees than 30 feet. Too close a spacing cannot be sufficiently condemned.

Pits must always be dug and filled before the rains commence, and if, after the soil has settled it is found to be below the level of the surrounding land, additional soil must be added in order to raise the planting site slightly above the normal ground level. On no account must young plants be left in a depression. Water logging is fatal and accounts for the large number of deaths experienced by the growers at the present time.

Jungle growth must be kept down at all times and the land well worked. This is one of the reasons why the cultivation of ground crops is strongly advocated. Ground crops necessitate the cultivation of the land, and generally the application of some kind of fertilizer, *i.e.* sessamum cake sludge, farmyard manure.

If the orchard is of such size, or for any other reason it is not possible to ground-crop the whole area, then the area remaining uncropped should be put down to a cover and green manure crop, because, on the land which has been cleared of jungle and worked, soil erosion is bound to occur.

When the selected orchard site happens to be on the lower slopes of the hills or is steeply undulating, particular care should be given to lay-out. There is no greater limiting factor to the useful life of an orchard than the washing away of the soil and sub-soil by heavy rains, and the lay-out of an orchard largely determines whether soil erosion and washaways can be checked. Contour planting is strongly recommended for all hill side and steeply undulating areas.

With regard to the question as to whether it is profitable to apply fertilizers direct to the trees, it is considered that more healthy trees, greater resistance to disease and heavier yields of better quality fruit would result from the prudent application of suitable fertilizers.

Orchard Sanitation is of great importance.—All dead and decaying branches must be removed from the trees and burnt. Spraying with Bordeaux mixture 5 : 5 : 50—once or twice before flowering time will also be helpful in preventing the spread of disease. There is no question but that orchard sanitation will lead to a considerable increase in the number of sound fruits, and therefore, in all probability to higher prices being paid for the fruit in the local market. It will certainly lead to greater possibilities in the way of successful export to other countries.

There is considerable scope for improvement in the method of harvesting. It is known that the pericarp is very sensitive to injury and to allow the fruit to drop to the ground, or to fall one upon another is conducive to internal injury.

Small bamboo ladders should be employed and the fruit collected by hand. It cannot be over-emphasized that all handling of the fruit should be as gentle as possible.

At the present time pruning of any kind is not practised and little or no information on the subject is available. The tree as a general rule is a fairly clean grower ; that is, it does not become a tangled mass of stems, branches and leaves. There are to be found, however, trees which produce vigorous erect shoots that spring out along the main stem, usually when the tree is young. Such shoots are best removed. Trees must not be allowed to fork.

It is essential that irrigation be given during the dry weather if the orchard is not so situated as to obtain a plentiful supply of natural moisture.

EXPERIMENTAL CONSIGNMENTS TO THE UNITED KINGDOM FROM BURMA

A considerable amount of experimental work has been carried out by the Agricultural Department, Burma, to test the suitability of the Mangosteen for export.

Investigations were first commenced in 1929, when a small consignment was depatched to London by post. The fruits forming this consignment

were picked at two stages of ripeness, *i.e.* "beginning to ripen" and "almost ripe". The fruit in each of these two stages was subdivided into two lots : one lot being dipped in rubber latex and the other remaining untreated. The report received from the Empire Marketing Board indicated that all the untreated fruits arrived in better condition than the treated, but that the consignment was too small for conclusive results to be obtained. The report was sufficiently encouraging to warrant further experiments being carried out and suggested that still better results might be obtained if the fruits were carried in cold storage.

Accordingly in 1930, a further and larger and similarly prepared consignment was dealt with. In this case a portion was carried in cold storage (35°F. to 38°F.) and the rest under ordinary storage conditions of shipment.

From the report received from the Empire Marketing Board it was clear that the fruit carried under refrigeration was superior, especially those picked at the "almost ripe" stage of maturity. The "beginning to ripen" failed to mature properly.

The majority of "almost ripe" fruits carried in cold storage arrived in good condition, but had a slightly alcoholic flavour which it was considered might be due to the low storage temperature. It was suggested that a more suitable temperature might be 50°F.

As regards the latex-treated fruit no marked difference was noted between the fruits picked at the two stages of maturity or carried at different temperatures, *i.e.* 35°F. to 38°F. and ordinary storage, and the treatment was not effective in reducing the excessive hardening of the rind. As the latex membrane was found to be so thin as to be hardly imperceptible it was suggested that a thicker coating of latex should be tried in future consignments.

The consignment shipped in 1931 consisted of 20 crates, each crate containing 50 fruits. As in the previous years the fruits were picked at the "beginning to ripen" and "almost ripe" stages of maturity, but on this occasion each stage of maturity was subdivided into three groups, *i.e.* untreated : once dipped and twice dipped in rubber latex. The whole consignment was carried in cold storage but on account of the indications of low temperature injury found in the previous year, the Shipping Company were requested to carry a temperature of 50°F. to 55°F.

This shipment marked a definite advance on previous tests, the sound fruits were normal in flavour, fresh and attractive in appearance and did not show excessive hardening of the rind. Fairly severe wastage, due to *Diplodia* sp. occurred in all crates and a number of specimens forwarded to the Cambridge Low Temperature Research Station were reported on as follows :—

"A *Diplodia*, possibly *D. natalensis*, now *D. gstsypina* or *Physalosporo gossypina*, seemed responsible for most of the damage. There was also a white fungus. On one mangosteen it produced spores of a *Pestalozzia* type."

There was no marked difference between the once and twice dipped fruits. Latex treatment was effective in retarding the rate of transpiration of moisture from the fruit thus preserving its fresh appearance, but the report on the consignment received from the Empire Marketing Board states :

"Since it now appears, however, that untreated mangosteens may be shipped under suitable conditions it is doubtful if the advantages resulting from latex treatment are sufficient to justify its use."

As in previous years the "almost ripe" stage of maturity gave the best results.

Of this consignment 250 fruits were forwarded to a West End Store for disposal and realised 3*d*. to 4*d*. each according to size. This was the first attempt at placing the mangosteen on the London market and was entirely successful.

In continuation of experiments carried out in 1929, 1930 and 1931, further consignments were shipped to the United Kingdom as follows :

Year	*No. of Consignments*	*Total No. of Fruits*
1932	2	2,000
1933	3	4,400
1934	2	2,400

Although a large part of the 1932 shipment was sold by a Covent Garden Market firm of fruit importers at exceedingly satisfactory prices the mangosteen was not exported on a commercial basis prior to 1933.

The consignments of 1933 and 1934 were made on a commercial basis, only a representative part of each consignment being forwarded to the Empire Marketing Board and Department of Scientific and Industrial Research, for examination and report thereon. The fruits forming all consignments were picked at the "almost ripe" stage of maturity and carried in cold storage at a temperature of 50° F. No fruit was treated with latex.

A certain proportion of the fruit forming the 1934 shipment was treated with a 1 per cent. formalin solution for 15 minutes and then air dried. The treatment appeared to be effective in controlling wastage to some extent but it was clear that it did not prevent rapid wastage in the few days after discharge from the ship's cool store. Further experimental work on these lines is required and will be undertaken in 1935.

The work carried out to date clearly indicates that :

(*a*) the mangosteen is a suitable fruit for export provided that it is (i) disease free before shipment, (ii) picked at an "almost ripe" stage of maturity and (iii) carried in cold storage at an approximate temperature of 50° F. ;

(*b*) the profits obtained are commensurate with the labour involved ;

(*c*) the most suitable form of packing is as follows :

(i) Crate made of a light wood : dimensions—

Ends $12'' \times 2\frac{3}{4}'' \times \frac{1}{2}''$
Shooks $18'' \times 5\frac{1}{2}'' \times \frac{1}{4}''$
Cleats $12'' \times \frac{1}{2}'' \times \frac{1}{4}''$

(ii) Packing : wood-wool ; 25 fruits per crate wrapped in tissue paper.

(iii) Grading : all fruits in one crate to be of a size.

COMBATING INSECT PESTS*

CROP production is a very keen contest between nature and man. A farmer runs a race with soil, climate and enemies of crops, and it is but very rarely that an Indian farmer wins the race. It may be claimed that, with efforts, he can mould the soil for his purpose, and be independent of heaven's mercy for water where facilities for irrigation exist, but climate is beyond his control and the gods of seasons are rarely kind to him. He lives perpetually in terror of dust-storm, drought, excessive and untimely rain, hail storm, frost, and so on, and in addition to these, diseases and pests threaten his crops. The enemies of crops are indeed numerous and range from the ultra-microscopic viruses, which pass through the finest filter, to elephants. The most numerous and the most tenacious of all these are the insects which cause our farmers untold losses.

Nature has endowed these animals of small size an organization most suited for rapid increase in numbers and there is hardly any matter of animal or plant origin living, dead or decaying, which does not provide food for some insects, and there is hardly a habitat in which insects are not found. Some insects feed even on opium and there is a fly the larvae of which live in pools of kerosene oil.

Such creatures man has helped to flourish. Man has cleared vast tracts of natural vegetation and brought under irrigation extensive arid regions, and on the land thus made fit for his use, he grows his crops, or in other words crowds together an enormous number of plants of the same type. He thus provides certain insects with immense quantities of easily available nutritious food.

Besides, man conserves animal and human food of every description : to this insects have free access, and they find conditions most suitable for their rapid increase. Near human habitation accumulate immense heaps of refuse, consisting of decaying organic matter, which provides certain insects with abundant food. Man has introduced plants of one country to another and with these he has brought in insect pests. India has given to the world a number of such insects and the compliment has been returned in the form of San Jôsé Scale, Woolly Aphis and Potato Tuber moth, to mention but a few. With his merchandise man has taken insects from one country to another and these enemies of man have thus crossed unsurmountable barriers without effort. Quick means of transport : railways, motor cars, steam-ships and now aeroplanes, all help in the spread of insect pests. Under natural conditions insects had numerous enemies, which checked their rapid increase ; unfortunately through his lack of foresight man has destroyed the abodes and actually killed off these maintainers of balance in nature. Numerous birds and reptiles

* By M. Afzal Husain, M.Sc. (Punjab), M.A. (Cantab), Punjab Agricultural College' Lyallpur in *Agriculture and Live-stock in India*, Vol. VI, Part II, March, 1936.

and other animals, which fed mainly on insects, man has reduced to a condition of impotency. In short, man's system of crop production—cultivation, irrigation, growing, harvesting and storing crops, disposal of crop remnants and refuse, has produced conditions which enable certain insects to escape the rigours of climate and attacks of their enemies and find abundant supply of easily available food. No animal has interfered with nature to the extent that man has done and in doing so he has helped his most virile competitors—the insects, to multiply unchecked. The punishment imposed by nature upon man for this interference is also very heavy. It has been estimated that in the United States of America, in spite of her most advanced pest control organization, insects cause a loss of 2 billion dollars annually. Fletcher estimates that in India the annual loss to sugar-cane, from bores alone is not less than Rs. 300 millions per year. During 1905 it was through the ravages of a single insect—the Spotted Bollworm of cotton—that the Punjab cotton growers suffered a loss which has been estimated at 5 crores of rupees. San Jôsé Scale is responsible for the destruction of thousands of fruit trees in Kashmir and the fate of this industry depends directly on the effort put in to check this pest. It has been stated that, at a very conservative estimate, the Indian farmers and fruit-growers pay their insect conquerors a tribute which is not less than Rs. 1,95,00,00,000, a year. As our population increases and our needs grow greater, we come more and more in conflict with insects, and therefore the fight is becoming keener and more intensified every day, and at every stage insects defy man's efforts for mastery over the resources of the globe. There is nothing to show that man's victory over insects is either near, or sure.

Since prehistoric times man has waged war against insects and has evolved varied methods to save his crops and crop-products from depredation by these foes. Some of these methods in their natural simplicity appear most crude, while others based on the highest scientific knowledge and mechanical skill are most ingenious.

The simplest and natural method of "hand-picking", which monkeys and human beings employ to get at the body-louse, has survived up to the present day because of its efficacy. A number of our important pests, for example, the Red Pumpkin beetle and the Egg-plant Lady-bird beetle can be effectively controlled, over small areas, by this method. Where childish enthusiasm can be directed into useful channels, or the cultivators have spare time, this simple method may yield results of value even over larger areas. Sugarcane Top Borer moths and caterpillars of Lemon Butterfly have been successfully hand-picked. What is captured may be crushed, but a more elegant procedure is to drop the catch into a receptacle—for example an old cigarette tin suitably stringed—containing water with a layer of kerosene oil.

Some insects when disturbed fall down from a tree and may be collected in sheets or umbrellas. Some beetle pests can be effectively controlled by this method.

A number of our serious crop pests lay eggs in clusters, and it is possible to crush such egg clusters *in situ*, or to hand-collect and destroy them. Such insects as the Sugarcane Pyrilla, Sugarcane Moth Borers, Hairy Caterpillars often yield to this treatment. Collection of eggs is one of the measures of

locust control and during locust invasions enormous quantities of egg masses have been dug out of the soil and destroyed.

Among aids to hand destruction of pests mention may be made of such simple contrivances as the fly-flappers, insect hand-nets, sticky rackets, etc. In the Punjab, hand-nets have been very successfully used against Sugar-cane Pyrilla. In the hands of an army of boy scouts this simple implement may work wonders. An elaboration of the hand-net is the "field-bag", which is effective against grass-hoppers. To the same category belong the hopper-dozers.

One method of dealing with insects boring into stems of fruit trees is to hook them out by means of metal wires with hooked or barbed ends.

Trapping has been used effectively against insects. The simplest form of trap is a pit, trench, or ditch. Insects moving in large swarms readily fall into ditches dug in their path. When in these ditches they can be earthed over. This method has been extensively employed in locust control, and, in conjunction with barriers has proved most effective. Locust hoppers may even be driven to a trench made for their reception.

Lures are often used to entice insects to their doom. Entomologists have taken advantage of the fascination which light exercises over certain insects, and have evolved light-traps varying from a lamp placed over a vat containing kerosenized water to elaborate automatic electric appliances for attracting and capturing insects. The most recent of these is the violet ray apparatus. Lighttraps have given excellent results against *Amsacta* moths. *Ber* beetles (*Adoretus nitidus*) and *Nephotettix*.

It is presumed that insects are guided towards their food, most probably by some sense akin to our smell, and this is the sense which most often brings the sexes together. If agents of these attractions can be discovered, it should be possible to devise effective traps for capturing most insect pests. Insects' response to certain chemicals is well-known. Sweetened baits are used to capture flies, ants, cockroaches, etc., and sweetened beer is used for house crickets and moths, and other chemical traps have also been tried. The males of the Mediterranean Fruit Flies are attracted strongly towards kerosene oil, and those of our Peach Fly towards euginol. Unfortunately, the females are not influenced in the least by these chemicals.

Heat is an effective insecticidal agency. No insect can long survive an exposure to a temperature of 150° F., and most of them succumb to 130° F. if exposed to it for a few hours. In India, where bountiful nature has bestowed us with a free source of strong radiant energy, sun-heating is an economical and effective measure against insect pests. Such material as weevilled grain, cotton seed harbouring hibernating Pink bollworms, insect-infested seeds, drugs, spices, woollen material, books, furniture, etc., can be sun-heated. It is also possible to raise the temperature of a room sufficiently high to destroy insect life. Modern flour mills, grain elevators, ships, glass-houses, etc., are provided with permanent installation for heating them to the required temperature. There are machines available which heat to a temperature lethal for insects, infested grain, or seed, which is run through. In Egypt such

heaters are used extensively in campaigns against the Pink bollworm of cotton, the hibernating caterpillars, which are responsible for the carry over of the pest, are thus destroyed. The same measure has been proposed for the United Provinces. Whether heated in a machine or by exposure to sun, this pest can be checked by systematic and organized campaign of heat treatment of all seed, prior to the emergence of moths.

Heat cannot be employed in all cases. Rice exposed to a temperature of 130° F. is spoiled because the enamel of the grain cracks, similarly tobacco deteriorates on exposure to high temperature. Therefore, low temperature is employed in these cases. Cold reduces insect activity and there is practically no insect damage if the temperature is below 40°F.

Fire is employed to destroy insects. Locust hoopers congregating in thick swarms over dry bushes may be burnt to death. Flame throwers although expensive to work, have been used extensively in locust campaigns. If a material is badly infested and its destruction will save a much greater damage, then fire is a valuable "purifier", hence the recommendation "cut and burn". All refuse collected from stores, mills and factories suspected of harbouring insect pests, should be consigned to fire. Such crop remnants as contain hibernating stages of insect pests should be pulled out and used as fuel. Borers of sugarcane, rice, maize and *jowar* will be greatly reduced, if stubbles of these crops are collected and burnt before the emergence of moths after winter. Burning cotton sticks before the new crop is sown will eliminate many of the cotton pests.

Poisons—man's favoured weapon against his enemies—came into use quite early in fighting insects. Some poisons act when taken internally (stomach-poisons), and the commonest and most efficacious of these are the arsenicals. These are poisonous to man and domesticated animals and for this reason there is considerable, although unjustifiable, prejudice against them. In 1923 the U. S.A. used 45 million pounds of arsenicals without any serious mishap. Recently, however, some flourine compounds of sodium and calcium, and other chemicals, have been discovered which are distasteful to poultry and not so poisonous to cattle and man.

The stomach-poisons are applied to the food of the pest. Either a thin film of poison is spread over the surface of the plant, which the pest devours, or it is mixed with a material which the pest would eat readily (poison-baits). The poison-bait of bran, or other similar material, is the most efficacious method of dealing with locusts and grasshoppers, cutworms and house crickets, and insects with similar habits.

A large number of serious plant pests puncture the tissues and suck the plant juices. Such insects cannot be killed by stomach-poisons, and insecticides have to be used which cause their death when coming in contact with their bodies (contact-poisons). Soaps, emulsions of mineral oils, sulphur compounds, napthalene compounds, rosin compounds, etc., have such action.

A number of plant products of excellent insecticidal value are available ; of these some act as stomach-poisons, *e.g.*, hellebore, while others as contact poisons, such as nicotine and pyrethrum, and still others act as both, *e.g.* derris.

Insecticides whether in the form of dust, suspension, emulsion, or solution must be applied evenly, quickly and economically.

Very rapid advances have been made to evolve suitable spraying and dusting machinery. From simple hand syringes and dust shakers we have advanced to elaborate power sprayers and dusters. Certain orchardists have stationary power pumps with permanent pipes laid among rows of trees, and on the other extreme we have aeroplane dusting and spraying of crops and forests. How efficacious aeroplanes are may be judged from the fact that an acre can be sprayed in seven seconds. Locust hoppers are poisoned by dusting their food plants by means of aeroplanes and attempts are also being made to deal with the flying swarms from the air. In India no aeroplane dusting or spraying has been tried so far.

Most of the insecticides, and spraying and dusting appliances are imported into India, and very often the prices make their use prohibitive. The future development of the insecticidal method of insect control depends directly on the availability of cheap and suitable insecticides and dusting and spraying appliances.

Poison gases have been employed very commonly against insects attacking stored grains and stored products, and against other household pests. The fumigants most commonly used are hydrocyanic acid gas and carbon bisulphide, but sulphur dioxide, carbon monoxide and dioxide, carbon tetrachloride, para-dichloro-benzine, and even pyrethrum powder and tobacco extracts are also employed. The latest development of this method is fumigation under vacuum, where the material to be fumigated is placed in a special container the air of which is withdrawn, and the fumigant introduced. This facilitates penetration and reduces the time of exposure. Fumigation, with hydrocyanic acid gas, of living plants in green houses or in special boxes and even under "tents" is an effective method of pest control. The Indian Central Cotton Committee fumigate all consignments of American cotton to safeguard against the entry of the notorious Boll Weevil of cotton, and all living plants imported into India have to be similarly treated at the port of entry to safeguard against foreign pests.

The ancient practice of storing grain with a small quantity of an amalgum of mercury with oil or ashes has a scientific basis. It has been found that in the presence of mercury vapour insect eggs do not hatch.

To fight soil-insects, insecticides in the form of dust, liquid and gases are employed. Dusts may be sprinkled over or dug in, and liquids and vapours are forced in. Soil injectors of different types have been evolved leading from hand injectors to traction injectors.

The most interesting development of chemical warfare against insects is through injections of chemicals into the tissues of plants. Barium chloride, aluminium sulphate, pyridine in very weak solutions have given good results against Wooly Aphis of apples. Small pieces of potassium cyanide introduced into the trunk of trees destroy scale insects and other sucking insects, but the process is not without risk. Trunk borers of trees may be treated by plugging the burrow with cotton wool soaked in chloroform-benzine mixture or similar other material.

Even more ingenious than the above is the development of immunity or resistance among plants through soil treatment. Mosquito Blight of tea has been effectively checked by applying phosphatic manures. This field of attack presents immense possibilities. It is reasonable to suppose that soil conditions may so influence a plant as to develop immunity or resistance against certain pests.

Insects have also been destroyed through ethereal vibrations. The Cigar beetles have been destroyed by exposing boxes of cigars to Roentgen rays, and radio waves have been used for the control of plant pests. It is expected that ultrasonic waves will prove of great value in insect control.

Valuable crops may be protected by enclosing them within trenches or metal sheet barriers. Invading bands of locust hoppers and similar other swarming insects are thus kept away. Valuable seed beds may be protected by wire-netting and valuable fruits may be enclosed in paper bags, or bags of netting. Wire gauze of suitable meshes wrapped round the stem of a fruit tree is a good protection against attacks of borers, such as the fig-tree borer.

A number of insects lay their eggs in the soil and their young ones on hatching out crawl up the trunks of trees to reach the soft shoots or flower heads. These insects may be stopped in their ascent by the use of barriers applied to the trunks of trees. Bands of smooth-glazed paper, smooth oil cloth, tin sheets, coal tar and other sticky materials form effective barriers. Bands of fluffy cottons are particularly efficacious against *Monophlebus* nymphs that crawl up the trees from the soil. A ring of sticky substance, heavy oil or coal tar painted on the soil does not permit insects to reach valuable plants. Coal tar and gas refuse are good repellents to safeguard against white-ant attacks. Tapes soaked in corrosive sublimate are not crossed over by ants.

Insects, although the favoured of nature, are an important source of food supply for some animals and are subject to attacks of organisms causing disease and death. And just as is the case with human beings overcrowding in a locality encourage epidemics. Whenever an insect appears in enormous numbers its enemies also increase. Bacteria, fungi, protoza and parasitic-worms the chief casual agents in human diseases—also parasitize insects. Quite often severe onslaughts of insect pests are wiped out by these organisms. Of the animals with back-bone, some fish, all frogs and toads, many lizards and snakes, numerous birds, hedgehogs, shrews, bats, lemurs, monkeys and many other mammals mainly subsist on insects. Larvicidal fish, whose favourite food are mosquito larvae, have secured a place of honour among measures of malarial control. Birds, because insects form the staple diet of a large number of them, are farmers' best allies. It has been truly said that without his beautiful feathered friends, man will find it difficult to hold his own against insects. Unfortunately it is this group of beneficial animals which man has reduced in numbers to his great misfortune. For their useful work in dealing with the locusts the starlings have received government protection. Bird protection and encouragement is of great value to the farmer. It must, however, be remembered that in absence of insects even the insectivorous birds feed on grain and fruit, and it is, therefore, necessary to watch bird increase and activity with great care. The value of the study of birds and their food

to an agricultural country cannot be over-emphasised. Combining fruit-growing with poultry-farming has evident advantages. In a limited area a pen of poultry would clear off grass hoppers within a short time, and will make short work of other insects found on the surface of the soil or just below. Even insect-eating bats have their value.

The chief enemies of insects are, however, those of their own kith and kin. It has been estimated that in a given area 25 to 30 per cent. of the insects present feed on other insects. Were it not for this army of beneficial insects, the harmful insects would have obtained a sure victory over mankind. The commonest examples are the Lady-bird beetles, Lace-wing flies, Hover flies, Dragon flies, predacious beetles, preying mantids, flies and wasps and members of other groups. These tigers among insects devour Green-flies, White-flies, Scale-insects and other insects. There is yet another section of this useful army which consists of parasites—small wasps, flies and members of certain other groups. They lay their eggs on or in the bodies of insects and their young ones live on the tissues of the victim and kill it. All the stages from egg to adult may be parasitised.

Entomologists have attempted to array this army of beneficial insects on the side of man. In some cases wonderful success has been achieved. One single instance will be given. The Cottony cushion scale of citrus was introduced from Australia into California in 1868. By 1890 it had killed thousands of trees, and the citrus industry was in danger of being completely wiped off. From Australia 500 of the Lady-bird beetle predators of the scale were introduced and distributed among the fruit-growers. Within a year and a half the beetles had multiplied in sufficient numbers to check the scale.

Biological control of insect pests has given best results against introduced pests. In India, where most of the pests are indigenous, an equilibrium has been set up between the pest and its enemies, therefore without special efforts it is not possible to give a predator or a parasite a chance of winning the battle. There is, however, a great need for large-scale, intensive investigations to determine the possibility of biological control of insect pests.

For India with her low yield of crops, and poverty-stricken illiterate peasantry, the cheapest and simplest methods of insect control are the best, and prevention very often is better than cure. Most effective results can be obtained by carrying out farm operations intelligently. It is estimated that 95 per cent. of the insects pass some portion of their life-cycle in the soil. Tillage operations expose insects in the soil to the severity of climatic conditions—blazing heat, heavy frost or desiccation and to their enemies —predators and parasites. Very few insects can survive in a field which has been ploughed up often enough. Soil preparation is thus of great importance in insect control. Irrigation is also an effective method in pest control. White-ant attack on wheat or sugarcane can be checked by watering, and flooding destroys many other pests. Manuring to produce vigorous and quick growth, and early maturity also help in decreasing losses caused by insects. Soil conditions very often determine the degree of resistance that a plant develops against a pest, and soil conditions depend on tillage, irrigation, drainage, manuring, etc. Altering time of sowing to escape insect attack also has great possibilities. In places where mole crickets injure wheat, delayed sowing is an effective remedy.

A proper crop rotation is useful in combating insect pests. It has been seen that cotton sown after gram is likely to be damaged by *Lygus*, which feeds on gram and can also feed on cotton.

Cleanliness on the farm or in an orchard is of utmost value in insect control. Accumulation of rubbish, fallen leaves, old vines, dry twigs, stones, etc., provide shelter to some insects during the intense heat of summer and the severe cold of winter. It is in such situation that insects which are active at dusk and at night, lie concealed during the day, and the day-insects spend their night. Remnants of crops which are left in the field after a crop has been harvested provide food to some and shelter to many. Borers of rice, maize, *jowar* and sugarcane overwinter in the stubbles that are left in the fields. Weeds that grow among crops and fruit trees often provide food and shelter to insect pests. Sprouting crop remnants or volunteer plants supply food to insects at a critical stage of their annual cycle when their main food supply is not available. To control your insect foes destroy their shelter and cut off their food supply, particularly at the most critical time of their seasonal cycle. Very often the most serious pests of crops are very specific in their choice. Spotted bollworm of cotton would confine itself to the Malvaceous plants—the family to which cotton, common vegetable *bhindi* (ladies finger) and common garden plant *Althea rosea* belong. Top borer of sugarcane has only *sirhandu* as its chief alternative food plant. Red pumpkin beetles do not feed on any plant outside the Cucurbits.

In some cases the alternative food plant is used as a "trap crop", a crop which attracts the pest. This crop is grown to attract the pest to itself and when the pest has concentrated on it, the crop with the pest is destroyed, *i.e.* cut and fed to cattle or ploughed in or burnt.

Domestication leads to decrease in the natural resistance of plants and animals. The more highly domesticated or "improved" a variety, the more severely it is likely to be attacked. There are, however, some varieties which, to a certain degree, combine resistance to pest attack with other useful qualities. The possibility of evolving such varieties has been demonstrated. A cotton which is Jassid-resistant has been produced, and there are varieties of Coimbatore sugarcanes which are partially resistant to Pyrilla and Top borers. It is known that apples grafted on the root-stock of Northern Spy and Winter Majetin develop resistance against Woolly Aphis. It is very essential that when new varieties have been evolved their behaviour towards the commoner pests is carefully studied under varying conditions. Moreover, it is very important that the real basis of such immunity is scientifically investigated, so that we are able to build up a science of plant resistance. Very often a very small factor, which may be considered of no consequence otherwise, such as slightly increased hairiness, a little toughness of the cuticle, a slight change in the acidity of the cell-sap, a more vigorous growth at a particular stage, a particular habitat bringing about alteration in the micro-climate for the insects may have far-reaching benefits.

It must, however, be remembered that there does not exist any plant that completely defies insect attack, and it is not likely that man will ever be able to produce a variety of any of his domesticated plants which will possess

complete immunity, from all insects, for all times. There will be a continual race between our defensive efforts and insect attacks. Whoever can make more rapid progress is sure to win.

This very brief and cursory review of the measures, which man has evolved to combat insect pests, shows that all the elements of human warfare are reflected in our attempts to fight insects. From hand-to-hand fight we have advanced to poisonous gases and attacks from the air. We are using electricity and are looking forward to death waves. There are, however, a few aspects in which there are tremendous differences. Our internecine wars we fight by means of a thoroughly trained and organized force. Most nations have enormous standing armies, kept at high efficiency and at all times fully prepared for action. In some countries there is conscription and every able-bodied man is trained to fight. To combat insects we have no trained army and every cultivator without knowledge and training is expected to fight his battles by himself. Further, human wars are carried out with utmost abandon and the question of expense, although fundamental, is often relegated to the distant background. Nations may indulge in the luxury of wars on borrowed money. On the other hand when dealing with pests of crops, the question of first importance is that of expenditure, which is to be carefully considered in relation to the advantages gained and the measures to be adopted must necessarily be most economical. If it does not pay to kill an insect pest, it is not killed. No army can fight its battle to a successful issue, unless scientific research has provided it with weapons superior to that of its foes and through regular practice of war-craft it has not reached a high standard of efficiency, and unless it knows, through its spies and through field reconnaissance, all about its enemies. Even then, the success is doubtful unless the entire resources of a nation—human, animal and material—are placed at the disposal of the army. Surely when fighting insects our most terrible foes—we must be armed with a full and detailed knowledge of their habits, behaviour, weaknesses, and disseminate this knowledge among the entire community to create a communal feeling against insects and prepare every man and woman, boy and girl, for this most noble of wars. In European countries training for defence against poisonous gas attack is being taught to the civil population ; then has not the time arrived when the entire population should be acquainted with the methods of defence against our bitterest foes—the insects—constantly present and always at war with us inflicting us with foul diseases, causing us terrible loss in life, food and property ? Thus there is a growing need for more and more research in methods of combating insects, and public instructions in warfare against insects.

Without organization insect control is impossible. A solitary individual, who spends money and energy on insect control, wastes his resources, if his neighbours do not undertake such measures. Therefore, co-operation amongst the farmers is absolutely essential for insect control. To obtain the necessary co-operation and concerted action pest control organizations are essential. Legislation is the basis of organization. We must have laws to enforce co-operative action against pests. We must also have laws to safeguard the carriage of pests from one locality to another. Some years ago in Madras a

Pest Act was introduced and recently the Kashmir Durbar has legislated against San Jôsé Scale. It is true that all plant material imported into India is fumigated at the port of entry, but there is no check to the introduction of pest over the land routes and the pest laws are absent in most parts of the country.

Our country is far behind other countries in the development of pest control measures, and yet we have to compete with those countries in the world market. Our crop yields are low and in most cases the lowest in the world ; we can no longer ignore the waste that is going on perpetually. Even 10 per cent. of the Rs. 1,95,00,00,000, that we allow insects to take from us, if saved and spent on rural reconstruction, will make India the land of peace and plenty.

SOIL EROSION IN KENYA*

OF recent years various commissions have investigated the problem of soil erosion and denudation both in South and East Africa. In 1929 a commission under the chairmanship of Sir Daniel Hall attributed erosion in the native reserves of Kenya to the destruction of shrubs and young trees on the higher ground by the ubiquitous goat. The report states that to the goat more than anything else may be attributed the deforestation of Greece and other Mediterranean districts where the soil has been completely washed away, creating on the one hand bare hillsides, and on the other, swamps in the valleys.

The South African Economic Commission of 1932 reported that in the Native Reserves of the Union, with few exceptions, the carrying capacity of the soil, both of humans and livestock, is on the down grade, and that unless the present state of affairs is soon remedied there will be in the Union, within one or at most two decades, an appalling problem of human poverty.

The Morris-Carter Commission (Kenya 1933) discusses at length the same problem as it affects the Suk, Kamasia and Machakos districts in Kenya. In the Suk district, owing to over-stocking, the grass has entirely disappeared over large areas, giving way to a growth of dense thorn scrub which absorbs all moisture and prevents the growth of grass. In the Machakos Native Reserve the report states that the land is rapidly deteriorating owing to overstocking; and that in the Suk, Njemps and Samburu districts the natives appear to show no regard for the ruination which is going on before their eyes, but devote their lives to amassing large herds of uneconomic livestock which are fast turning their country into a desert. In West Africa also the danger has been recognized. Recent investigations show that owing to faulty land management, valuable agricultural land in French and British Nigeria is being absorbed by the Sahara desert at a rate estimated to exceed a kilometre a year. Professor Stebbing states that the Sahara has advanced 300 kilometres southward in three centuries.

It is well known that in Northern Africa what is now desert was once fertile country, carrying a large and highly civilized population.

In Kenya the Machakos districts of the Ukamba Native Reserve provides a good example of rapid erosion and deterioration through over-stocking. This district, lying on the eastern edge of the Kenya Highlands was first occupied and administered in 1889 by the Imperial British East Africa Company. The total area of the district is 2,166 square miles and the population is 239,000 or about 110 per sq. mile. The people are mainly pastoralists, but about 140,000 acres are estimated to be under cultivation,

*By S. F. Deck, formerly Senior Commissioner, Kenya Colony, in *Tropical Agriculture*, Vol. XIII, No. 3, March, 1936.

the main crops being millet, beans and sweet potatoes. The rainfall in the western part of the district, where most of the population is concentrated, averages about 30 inches per annum. The average elevation is about 5,000 feet above sea level, but the district is intersected by lofty mountain ranges some of which rise to an altitude of 7,000 feet or more. The geological formation consists mainly of schistose rocks the detritus of which provides a fertile soil which, with reasonable treatment, can produce excellent crops and grazing ; but it is not a strong soil and does not stand up well to hard wear and tear. The natives live in small groups and the average village does not contain more than a dozen huts, *i.e.*, about four or five families. The average number of cattle per family is five and of sheep and goats 6½. At first sight this would not appear an unreasonable allowance ; but, according to the report of the Carter Commission, it means that 100 acres of land have to maintain 20 cattle and 30 sheep and goats ; whereas the District Veterinary Officer in his evidence before the Commission estimated the carrying capacity of the district in its present condition at one head of cattle to 30 acres, without sheep and goats. That is to say the district is carrying about six times the number of cattle it can reasonably accommodate, in addition to some 300,000 sheep and goats. Sales to outside markets do not exceed 20,000 head of cattle per annum, and of recent years the cattle have deteriorated both in size and milk yield.

The denudation and soil erosion which are rapidly turning this once fertile district into a semi-desert are of recent occurrence. When the district was first occupied and administered in 1889 the cattle throughout Eastern Africa had been decimated by rinderpest, numbers were few and grazing ample. The population was smaller and the forests on the high mountain ranges were still intact. They served as places of refuge for the natives when threatened by marauding Masai. But with the establishment of *Pax Britannica* inter-tribal raids have ceased and veterinary services have protected the cattle from disease. The area under cultivation has increased and with it the forests on the high ranges have vanished, with the exception of a few sacred groves to which the natives still hopefully repair to pray for the restoration of the soil fertility which they themselves have, all unwittingly, destroyed. The hillsides, scarred and furrowed by innumerable stock tracks are now not only treeless but grassless ; and in many places, successive rainstorms have converted the furrows into deep dongas, down which the soil is washed into the valleys until the bare bones of the hillsides are exposed.

In some countries the soil washed from hillsides is deposited further down the valleys in the form of alluvial flats on which crops may be grown. Unfortunately for the Machakos district the ground falls too steeply to permit of such accumulations. The eroded soil travels down small mountain stream beds into the deep and rocky valley of the Athi River which carries it rapidly to the sea.

Every hillside cattle or goat kraal has become a focus from which the forces of erosion are set in motion. Stock tracks radiating from the kraal gradually furrow the friable soil which is rapidly carried away, not only by rain but also by the high winds which prevail through the long dry seasons from July to November and from January to March. Even the cattle

droppings around the villages, which might be expected to stimulate the growth of grass, fail to produce any effect. The manure dries very quickly under the tropical sun and is trampled to bits and blown or washed away before it has time to produce any effect.

Although the sands of the Sahara are not immediately threatening the highlands of Kenya, another desert of a different type but equally greedy of fertile acres is already lapping round the base of the mountain ramparts which guard the green "heart of Africa". The thorn bush desert of Somaliland has already pushed its way southward across the Juba and Tana rivers; and its southern extremity is advancing into the once fertile valleys of Ukamba.

The question is sometimes asked "Are men, cattle and goats the sole destroyers, or is the advance of the desert mainly due to climatic change, geological disturbance, or both?" There is reason to believe that the region lying north of the Kenya Highlands between Lake Rudolf and the Indian Ocean was, until comparatively recent times more fertile than it is today. The wells of Wajheir, the large reservoirs in Jubaland, now almost silted up and the ruins of ancient cities near the coast in areas where today no water can be found, all indicate that this region, not many centuries ago, supported a large and comparatively civilised population. Mount Marsabit is a volcanic range of recent origin, and it may be that its activity changed the face and climate of the surrounding country. But all this is conjecture. What we do know is that this desert, from whatsoever cause it originated, has advanced, is advancing and will advance still further wherever denudation and erosion provide an opening. Erosion in Kenya occurs in an aggravated form under the following conditions:—

1. Where the rainfall is definitely seasonal, *i.e.*, where there is a well-defined dry season of three months or more.

2. Where the annual rainfall is 30 inches or less.

3. Where the geological formation is schistose or a recent volcanic ash. The older lavas generally form a stiff compact soil on which erosion is less marked.

But whatever the conditions, erosion will occur sooner or later if overstocking is permitted. In Kenya the situation has been aggravated during the last six years by a sub-normal rainfall and a heavy infestation of locusts. Now there are various remedies for erosion, which can be applied without delay and at no great expense. The natives of the Machakos district are both intelligent and industrious. Under the guidance of Government officials they have afforested considerable areas on the hillsides and have dug ditches and planted hedges along contour lines to stop "wash". All this is to the good. But they are averse to the application of the sovereign remedy, the drastic reduction of their livestock, which is necessary to provide scope for any large-scale scheme of soil-restoration. This aversion is hardly surprising. Livestock is the basis of their most cherished social institutions. It is their standard of value. There is no question of the gold standard in Ukamba. The tribe is only concerned with the maintenance of the goat standard, which has been their economic creed for untold generations. Without livestock a family can hardly maintain social respectability; and a

suitor stands no chance of gaining the favour of the parents of his intended unless he can produce the customary cattle and goats.

In these circumstances it has not hitherto been considered advisable to enforce the ordinance providing for the compulsory culling of livestock. The difficulty of applying this law has hitherto been further enhanced by the inflated cash values which the natives place on their animals and by the impossibility of finding a market for many thousands of inferior cattle. The only possible method of disposing of them is through an extract and fertilizer factory. But whereas the native owner values a three-year old steer at about 20 shillings a factory could not at present prices pay more than six.

The position is a difficult one, but the problem must be faced. To enable the soil's natural cover of trees and herbage to re-establish itself, livestock must be excluded from the eroded areas. Where is it to go ? It is probable that a survey of the thorn bush desert lying to the east of the district between the Tana and Athi rivers would reveal areas of grassland where large numbers of cattle would find sustenance if adequate water supplies were available. A solution of this problem may be found with the help of bore-holes and pipe-lines. Compulsory culling could then be gradually imposed in order to prevent over-crowding round the new water supplies. It is an expensive method ; but when one reads that the President of the United States has decided to allocate two hundred millions to anti-erosion measures, one realizes that the task of restoring soil fertility is not likely to be a cheap one.

In the meantime the most suitable kind of vegetation for " holding the soil " in eroded areas suggests itself as an interesting subject for study and research.

MEETINGS, CONFERENCES, ETC.

Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon, held in the Ceylon Chamber of Commerce Rooms, Colombo, on Saturday the 28th March, 1936, at 9·30 a.m.

Present.—Mr. James Forbes (Jnr.), (Chairman), the Acting Director of Agriculture, Col. T. G. Jayawardene, V.D., Messrs. R. G. Coombe, J. D. Hoare, D. H. Kotalawala, M.S.C., E. L. Fraser, J. C. Kelly, A. W. L. Turner (Secretary), S. C. Bissett (Accountant) and Dr. R. V. Norris (Director, T.R.I.).

Absent.—The Hon'ble the Financial Secretary, Messrs. I. L. Cameron, R. P. Gaddum and D. T. Richards.

Notice calling the Meeting was read.

Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon, held on the 22nd February, 1936, were confirmed.

MEMBERS OF THE BOARD

The Chairman welcomed the new Acting Director of Agriculture, Mr. E. Rodrigo, and introduced him to the Members of the Board.

The Chairman announced that the Planters' Association of Ceylon had elected Mr. B. M. Selwyn to act as one of its Representatives on the Board during the absence on furlough of Mr. J. D. Hoare from the 15th April to approximately the 15th October, 1936.

The Board recorded its thanks to Mr. Hoare for the services he had rendered.

FINANCE

Audited Accounts.—The Chairman said that the Finance Sub-Committee had examined the Auditors' Report on the 1935 accounts very carefully on the previous day.

On the proposal of Mr. R. G. Coombe, seconded by Mr. J. D. Hoare, the Audited Accounts as at 31st December, 1935, were adopted.

The Statement of Accounts, as at 29th February, 1936, was approved without comment.

EXPERIMENTAL SUB-COMMITTEE

There were no comments on the Minutes of the Meeting of the Sub-Committee held on the 18th January, 1936.

The Chairman explained that the Sub-Committee had held a further meeting on the 21st March, 1936, but the minutes had not yet been issued. That Meeting had decided to make the following recommendations :—

1. *Machinery*—

   (*a*) Purchase of an Experimental Drier.

   (*b*) Purchase of a Multiple Green Leaf Sifter.

The purchase of the foregoing items was sanctioned.

II. *Pruning Experiments at Peradeniya.*—The Sub-Committee recommended that when the present pruning cycle of the experiment was concluded at the end of April it would be unnecessary to continue the experiment at Peradeniya.

This recommendation was adopted and the Board passed a vote of thanks to the Director of Agriculture for having co-operated with the Institute over these experiments.

HALF YEARLY REPORTS OF THE SMALL HOLDINGS OFFICERS—JUNE TO DECEMBER, 1935

These were accepted without comment.

PASSARA SUB-STATION

The Chairman announced that the building had now been taken over by the Institute.

ACTING VISITING AGENT'S REPORT DATED 27-1-36

Recorded that a copy of this Report was sent to each member of the Board under cover of Circular No. 4/36 of the 6th February, 1936.

ANNUAL REPORT FOR 1935

Recorded that a copy of the Secretary's portion of this report was sent to each member of the Board under cover of Circular No. A.7/36, of the 28th February, 1936.

This portion of the Report was approved.

ANY OTHER BUSINESS

(*a*) *Yerba Mate.*—In accordance with the decision of the Board at its Meeting held on the 7th December, 1935, two Memoranda supplied by the Acting Director of Agriculture and Mr. S. C. Bissett were sent to all members.

No comments were made.

(*b*) *Dr. Tubbs' Visit to India.*—The Director stated that tentative arrangements had been made for this Officer to visit South India during the current year. It now transpired that Dr. Shaw was going home shortly, and as it was essential that Dr. Shaw should meet Dr. Tubbs he proposed that the visit be postponed till 1937.

This was agreed to.

(*c*) *Junior Staff Medical Scheme.*—The Director stated that Dr. J. G. Shrikhande had been duly elected representative of the Junior Staff Association on the Committee of this Scheme.

This was approved.

The Meeting terminated with votes of thanks to the Chair and to the Ceylon Chamber of Commerce for the use of the room.

ARTHUR W. L. TURNER
Secretary.

COCONUT RESEARCH SCHEME

BOARD OF MANAGEMENT

Minutes of the thirty-second meeting of the Board of Management held in the Committee Room of the Chamber of Commerce, Colombo, at 11 a.m. on Friday, May 15, 1936.

Present.—Mr. E. Rodrigo, Acting Director of Agriculture, in the Chair, Messrs. C. H. Collins, C.C.S., Treasury Representative, Graham Panditte-sekere, J.P., U.P.M., D. D. Karunaratne, J.P., Austin Ekanayake, Wace de Niese, Dr. H. M. Pieris and Mr. W. V. D. Pieris, Officiating Chief Technical Officer, who acted as Secretary.

MINUTES

The minutes of the previous meeting held on February 21, 1936, which had been circulated to Board members, were confirmed.

BOARD OF MANAGEMENT

The Chairman reported that three vacancies had arisen on the Board by reason of the cessation of membership of Mr. F. A. Obeyesekere, and by the resignation of Messrs. J. L. Kotalawala and Mr. A. W. Warburton-Gray.

Regarding the filling of the first two vacancies, the Chairman stated that he was in communication with the Hon'ble the Minister for Agriculture and Lands. Mr. Warburton-Gray's place would be taken in due course by a nominee of the Planters' Association.

ANNUAL REPORTS

The Chairman stated that owing to Dr. Child's absence on leave, the Technological Chemist's Report for 1935 had not been prepared in time for the meeting, but that it would be circulated to members in due course.

The Annual Report, as submitted, was adopted.

FINANCE

The statement of receipts and payments for the quarter ended March 31, 1936, was adopted.

Capital Account—Buildings.—The Chairman reported that the Board's sanction had been obtained by the circulation of papers to build a shed to house the Avery weighing machine and a concrete barbecue.

Running Expenses of Electric Plant.—A supplementary vote for Rs. 1,000 was passed.

ESTATE

The Progress Reports for February and March, 1936, were adopted.

The Chairman stated that husks would be used on the estate as much as possible but that in certain circumstances it was more economical to sell the husks and return their equivalent in the form of artificial manure to the soil than to utilise them on the estate.

The Board decided that the disposal of the husks from the estate should be left to the discretion of the Officer-in-Charge.

JUNGLE AREA

The Chairman informed the Board that he had been informed that Elapahalakelle was definitely reserved for village expansion and that no portion of it could be given to the Coconut Research Scheme, but that if the Coconut Research Scheme wished to have a portion of Kankaniamulle Reserve Forest near Dandagamuwa, it might be possible to get it unreserved.

The Chairman further stated that if Kankaniamulle were found to be unsatisfactory, it might be necessary to purchase the whole of Ratmalagara Estate and later dispose of any portion of it that was not required, the owners being unwilling to sell only the jungle area attached to it.

Mr. Pieris undertook to examine Kankaniamulle and submit a report to the Chairman.

The matter was deferred to the next meeting.

GIFT OF COPRA KILNS TO CO-OPERATIVE SOCIETIES

This matter was brought up for re-discussion and the Chairman said that according to the terms of the Coconut Research Ordinance, 1928, the Board had no legal authority for making the proposed gift and that, in his opinion, the offer should be withdrawn.

Mr. Wace de Niese agreed and reminded the Board that when that matter was first discussed, he had stated that the Coconut Board was contemplating measures to aid village copra curing and marketing and that it was not necessary for the Coconut Research Scheme to do the same, because it would result in an overlapping of activities. The Board decided that the offer of copra kilns to Co-operative Societies should be withdrawn.

EXPERIMENTAL

Circulation Paper No. 212, further programme of experiments to be carried out on Bandirippuwa Estate, etc., was tabled and adopted by the Board.

Pollution of Gin Oya.—The Board decided that the pollution of Gin Oya by the effluent waters of the Fibre and Desiccated Coconut Mills belonging to Messrs. J. H. Vavasseur and Co., was not a subject that concerned the Coconut Research Scheme, but was a matter for investigation by the Health authorities

Disposal of unserviceable articles.—A list of unserviceable articles was submitted to the Board by Mr. Pieris and it was decided that he should destroy or dispose of them in the most suitable manner and report at the next Board Meeting.

REVIEW

Soils—*Their Origin, Constitution and Classification. Second Edition.* By G. W. Robinson. Thos. Murby & Co., London, 20/-.

THE second edition of Prof. Robinson's book on Soils appearing as it does but three years since the issue of the first, is proof enough of its deserved popularity and intrinsic value. The only one of its kind to cover so wide a scope of soil science or pedology, it has been welcomed by the large group of scientific workers connected in any way with the study of the soil for its originality of treatment and modernity. It is not merely "a mere compilation of facts", but partakes "of the character of a work of art", reflecting the philosophy of the author on and presenting "an impersonal and impartial" account of the subject under review. Need it be wondered at that the book has become a 'best-seller' among recent scientific publications? The merits of the book as an authoritative and up-to-date work on pedology were drawn attention to in a review of the first edition in this Journal. (*The Tropical Agriculturist* Vol. LXXX, 1933, p. 316), and it is gratifying to note that these have been universally recognised.

The usefulness of the book has been enhanced in the second edition. Erroneous or misleading statements have been corrrected and obscure explanations clarified. Certain portions of the book which appeared to require amendment have been re-written. Others have merely been modified to permit of the inclusion of "corroborative detail". The changes effected are mainly in the chapters on the Pedogenic Processes, the Clay Complex, Base Exchange, Soil Moisture and Soil Classification.

In the chapter on Soil Moisture, reference is made for the first time in a book of this nature to the pF value of a soil which may possibly vie, in the realm of soil physics, with the pH value in the field of soil chemistry. Additional valuable information has been furnished on the chapters on Soil Groups and Soil Geography, which are perhaps the most characteristic of the book. It is noteworthy that consequent on the systematic study of local soils made since the book was first published, a brief account of the important

soil groups of Ceylon has been included in the chapter on Soil Geography. Altogether the amount of fresh material in the second edition is considerable, the narrative being increased by 63 pages. No fewer than 150 new bibliographical references have been added. The number of illustrations has also been increased, thereby augmenting its interest. Those who have found Prof. Robinson's first edition a most helpful and stimulating guide in their pursuit of soil research, pure or applied, and they are doubtless many, will not hesitate, in the reviewer's opinion, to take advantage of the enhanced usefulness of the second.—A. W. R. J.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MAY, 1936.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1936	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	730	647	512	..	218	..
	Anthrax	..	..	..	..	..	..
	Rabies	14	3	..	..	..	14
Colombo Municipality	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	1301	329	1257	11	33	..
	Anthrax	1	..	..	1	..	..
	Rabies	..	..	..	..	..	..
Cattle Quarantine Station	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	3	3	..	..	3	..
	Anthrax	19	5	..	19	..	..
Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	1256	289	1190	6	60	..
	Anthrax	4	..	..	4	..	..
	Tuberculosis	1	..	..	1	..	..
	Piroplasmosis	1	..	1	..	..	..
Southern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
Northern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	255	12	240	2	13	..
	Anthrax	..	..	..	..	..	..
Eastern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
North-Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	473	90	411	1	61	..
	Anthrax	..	..	..	..	..	..
	Rabies	19	2	..	1	..	18
North-Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	661	24	621	..	40	..
	Anthrax	..	..	..	..	..	..
Uva	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies	2	..	..	1	..	1
Sabaragamuwa	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	21	21	..	..	21	..
	Anthrax	..	..	..	..	..	..
	Haemorrhagic Septicaemia	3	..	..	..	3	..
	Rabies	2	..	..	..	..	2

Government Veterinary Department,
Peradeniya, 15th June, 1936.

M. CRAWFORD,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT—MAY, 1936

Station	Temperature: Mean Maximum	Temperature: Difference from Average	Temperature: Mean Minimum	Temperature: Difference from Average	Humidity: Day	Humidity: Night (from Minimum)	Amount of Cloud	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	85·4	−1·2	76·3	−0·9	77	88	8·5	33·81	25	+18·83
Puttalam ..	88·0	+0·3	77·2	−1·2	76	91	6·5	4·59	11	+ 0·85
Mannar ..	90·0	+0·2	79·9	−0·4	72	82	5·8	0·50	3	− 1·40
Jaffna ..	89·0	+1·3	81·7	+0·5	78	81	4·8	2·01	3	+ 0·36
Trincomalee ..	91·6	+0·5	79·2	+1·0	66	82	6·0	0·81	6	− 2·64
Batticaloa ..	90·4	+0·5	78·3	+1·1	68	84	6·2	3·14	9	+ 1·25
Hambantota ..	86·6	+0·7	77·1	+0·4	79	91	6·0	6·51	14	+ 3·08
Galle ..	83·5	−1·1	76·6	−0·8	84	88	6·8	20·18	22	+ 7·71
Ratnapura ..	87·2	−1·1	75·1	+0·5	79	93	7·8	26·89	28	+ 6·82
Anuradhapura ..	90·0	+0·4	76·3	+0·4	70	91	6·6	4·02	8	+ 0·89
Kurunegala ..	87·5	−1·3	75·3	−0·1	76	91	7·0	17·49	19	+10·81
Kandy ..	85·3	−0·9	71·1	+0·3	74	92	6·8	20·39	20	+14·40
Badulla ..	84·3	−0·6	68·0	+1·8	72	95	6·4	6·13	16	+ 1·45
Diyatalawa ..	77·0	−1·5	62·7	+0·9	76	92	7·3	5·91	16	+ 0·05
Hakgala ..	70·8	−2·0	57·6	+0·5	84	94	8·1	20·49	24	+12·53
Nuwara Eliya ..	67·1	−2·9	53·0	+0·1	85	96	8·5	22·60	23	+15·72

The rainfall for May was above normal in the hills, and in the south and south-west, excesses being unusually heavy over a large area. Many places on the western slopes of the hills, and in the south-western low-country, were more than 20 inches above their average for May, and some were over 30 inches above. The greatest excess above normal was 40·45 inches, at Nilloomally estate. A large number of rain-gauge stations, chiefly in the south-west, reported monthly totals of over 40 inches, the highest being 59·12 inches, at Kenilworth estate, while totals of over 50 inches were also reported from Carney estate, Watawala, Norton Bridge, Maliboda and Theydon Bois estates. For some of the stations in the south-west of Ceylon this was the wettest May on record.

A majority of the stations in the northern half of the Island, and in the country between the hills and the east coast, were below normal, most of these, except in the districts nearest the hills, reporting monthly totals of less than 2 inches.

186 daily falls of 5 inches or more were reported, chiefly for the 13th, 14th, 18th, 19th, 20th, 22nd, 23rd, 24th and 31st. Of these 23 were over 10 inches, the highest being 16·24 inches at Ratmalana aerodrome, and 15·10 inches at Hanwella Resthouse, both falls being for the 24 hours ending in the morning of the 19th.

Very little rain fell during the first three days of May. From the 4th weather conditions changed, and local afternoon or evening thunderstorms were common, the ensuing rain being generally heaviest in the hills and the south-west of the Island. It was particularly heavy on the 13th and 14th. From the 14th or 15th the barometric gradient seemed to become more noticeably south-westerly over Ceylon, and on the 18th and 19th there were unusually heavy rains in the south-west of the Island. The gradient then became irregular, and suggested the formation of a shallow low near Ceylon. On the 20th there was again unusually heavy rain in the south-west, and weather conditions, both on land and at sea, suggested that the monsoon was setting in. On the 21st the rain decreased, but between the 22nd and the 24th there were again many very heavy falls in the south-west, while conditions at sea near Ceylon continued rough. The heavy rains in the Kelani Valley, between the 18th and the 24th, were responsible for a major flood in the Kelani at Colombo. From the 25th to the 30th the monsoon rains decreased, though they were still fairly heavy, but on the 31st there was again unusually heavy widespread rain in the south-west of the Island.

Temperatures generally showed no marked deviations from normal. In the hills, however, day temperatures were generally below normal, and night temperatures a little above. Day humidities were generally above normal, particularly up-country, while night humidities were on the whole about normal, except in the hills, where they were above average. Cloud was generally above average. Barometric pressure was appreciably below normal. Winds were generally above normal strength along the south-west coast and about normal elsewhere, while their direction was mainly south-westerly.

H. JAMESON,
Superintendent, Observatory.